

The Finished Job on Jones St.

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SPREADING IT THIN

*Milford, Illinois, Fits Wearing
Surfaces to Dollars Until More
Dollars Shall Be Available.*

By JOHN C. BLACK

Field Editor, ROADS AND STREETS

SOMETIMES the engineer must make his dollar do the work—not of two, in accordance with the classic definition—but of three or four or five. And while he may resent the necessity, the problem stimulates him. Into the picture, alongside the engineer, comes the contractor; and a concerted effort by the two may bring surprising results.

Milford's Problem

Such a case happened early this year in the city of Milford, Illinois—a place of 1500 inhabitants in Iroquois County near the Indiana boundary. About ½ mile of old pavement had deteriorated to a point where it was practically impassable at more than 10 miles per hour, but meager repair funds gave little hope of relieving the distress or stopping the squawks of motorists.

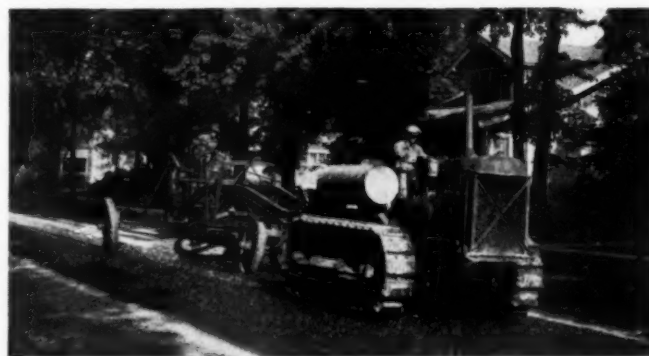
Mayor I. M. Goldstein, with \$3000 of motor fuel tax money available, asked Lawrence Collins, consulting engineer of Watseka, Illinois, and County Engineer of Iroquois County, what he thought might be done, and with some reluctance Collins undertook to answer.

Design and Specifications

Since it was impossible to supply all that was desired, the most practical course seemed to be to put down a surface combining reasonable immediate strength and smoothness with adaptability to future betterment. A design combining the necessary economy of materials and labor was found in Illinois "Specifications for Bituminous Surface Treatment of Existing Bituminous and

Rigid Type Pavements—Sub-Class A-2." These specifications provide for:

- (a) Cleaning, patching and shaping the existing pavement.
- (b) Priming with 0.20 to 0.25 gallons of bitumen per sq. yd.
- (c) Application of cover coat aggregate at rate of 30 to 40 lb. per sq. yd.
- (d) Application of bitumen to aggregate at rate of 0.20 to 0.25 gal. per sq. yd., mixing, spreading and rolling.
- (e) Application of final bituminous seal coat at rate of 0.20 to 0.25 gal. per sq. yd.
- (f) Application of seal coat aggregate at rate of 10 to 15 lb. per sq. yd., and rolling to finish.



Mixing Cover Coat



Patches and Patching Equipment

Mr. Collins used the top specification rate for cover coat aggregate, and increased the bitumen to 0.35 gal. per sq. yd. He also increased the seal coat aggregate to 15 to 20 lb. per sq. yd. Total bitumen application was 0.75 gal. per sq. yd. exclusive of material used in patches.

Wetherby is specific in saying that he thinks this would have been impossible except for the skill of this one man.

The old pavement was of brick, 30 ft. wide between stone curbs, laid on about 6 in. of sand, and having a 6-in. crown. Construction dated from about 1907. Its deplorable condition after 30 years' service was due to a combination of frost heaves and careless replacements after service trench and repair openings. Perhaps Milford was lucky it lasted so long, considering that having been laid with only a dry sand joint filler, it was subject to the worst possible conditions of moisture and freezing.

Two streets—Lyle and Jones—were treated under the A-2 specifications. A third street—Ashland—was resurfaced during the same season, but with a different type. The Lyle St. job had a net length of 1475 ft. and an area of 4917 sq. yd. On Jones St. the length was 1305 ft. and the area 4350 sq. yd. The stone curbs on both streets were in excellent condition and required very little attention.

Preparation of Old Surface

The first step was to cut weeds and clean the surface. In places this involved the shovelling out of 2 or 3 in.

The Dark Area at Right Is a Depression Which Has Been Primed and Is Now Ready for the Patch. The View Is on Lyle Street.



The Contractor's Problem

A. J. Shanks Construction Company of Watseka was low bidder. The thinness of the cover coat raised some misgivings, and Superintendent J. P. Wetherby states that he would have been unwilling to attempt the job had he not had a blade operator of unusual ability. The work was completed to the satisfaction of all parties, but Mr.

of mud and leaves for a distance of several feet from each curb. Then came a thorough sweeping with a Detroit Power Broom attached to a 1½-ton truck and operated with a power take-off. Two complete rounds generally cleaned the joints between bricks to a depth of ½ in., and left the surface ready for priming with asphalt, though a third trip was necessary in places. Sweepings were removed and gutters thoroughly cleaned by hand.

Materials

An RC-3 cutback asphalt, supplied by The Texas Company, was used for patching priming, cover coat and seal coat applications. It was received in tank cars, spotted on a siding heated by steam, and applied at a temperature between 185° and 195° F. For the prime coat, kerosene was added in the proportion of 200 gal. to each 1500 gal. asphalt. The kerosene gave better penetration—especially at the joints between bricks. Application was at the rate of 0.2 gal. per sq. yd.

Warm weather, which is essential to the fullest success with this class of work, prevailed throughout the entire period.

On Lyle St. all holes were primed with a hand spray before patches were placed, but this proved unsatisfactory



"Shooting" the Cover Coat

because of an unavoidable excess of RC-3, which required too long a time for curing. Greater convenience and more satisfactory results were obtained on Jones St., where the entire surface was primed with the truck distributor before patching was started.

The aggregates for patching, cover coat and seal coat were limestone-dolomite from the Thornton, Illinois, Plant of Moulding-Brownell Co.

The accompanying photograph indicates in a general way the extent of the patching which was necessary. As the holes were deep (many of them 6 in. or more) as well as numerous, the material requirement was large. One wonders if a saving could not have been made by flattening the old pavement with a heavy roller early in the spring while the sub-base was soft.

Patching Operations

Patching aggregate was required to have 95-100% passing a $\frac{3}{4}$ in. screen, 0-10% passing a No. 4 sieve, and 0-5% passing a No. 10 sieve.



Front and Rear Views of Chip-Spreading Operations

Aggregate and asphalt were mixed in a Rex one-bag concrete mixer, 0.10 gal. RC-3 being used to each 10 lb. of stone. Any larger proportion of asphalt was found to produce too rich a mixture. The material was placed by hand, raked to grade, and rolled with a 5-ton tandem roller, four roller passes being used in most cases. Areas along curbs were hand-tamped. Patches were cured about 24 hours before cover coat was placed.

Cover Coat

The A-2 specifications for cover coat aggregate require 95-100% stone passing a $\frac{1}{2}$ in. sieve, 0-10% passing a No. 4 and 0-5% passing a No. 10.

These aggregates were distributed in a 15 to 16-ft. strip down the middle of the street, in quantities to provide an even 40 lb. per sq. yd. over the full roadway width. They were then shot with RC-3 at the rate of 0.35 gal. per sq.



Rolling Patches

yd. of pavement, an 800-gal. Etnyre distributor with a 14-ft. bar being used for the purpose. Next came a Caterpillar 60 with a 12-ft. Adams grader, blading the material back and forth until the aggregates were thoroughly coated, after which they were spread and shaped.

Due to the thinness of the coat, this left occasional bare places. These were immediately spotted with fresh chips and asphalt applied by hand, after which the entire surface was given from 4 to 6 passes with the 5-ton tandem, the heavier rolling being done when weather was comparatively cool.

Seal Coat

Another 0.2 gal. of asphalt was applied for the seal coat. Then about 15 lb. of chips $\frac{1}{4}$ in. and smaller were distributed with a Buckeye spreader, broom-dragged and rolled.

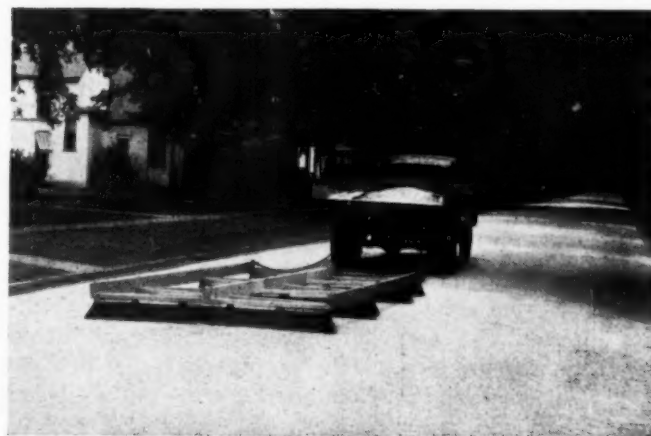
Fresh chips were spread lightly from time to time during the first 3 weeks after completion, in order to provide a little loose material on the surface until curing was complete.

Crew and Equipment

While crew make-up varied, it was in general as follows:

Patching Crew:

- 2 shovellers handling aggregate from stock pile to measuring box to mixer skip.
- 1 mixer operator.



Broom Drag at Work. The Service Truck Carries Chips for "Spotting."

- 1 man measuring and supplying asphalt with a bucket.
- 3 men wheeling mixed material to place.
- 2 shovellers spreading material.
- 3 rakers and tampers.
- 1 wheelbarrow spotter.
- 1 roller operator.
- 1 foreman.

This gang regularly placed and finished about 20 tons of material per 8-hr. day.

Cover Coat Crew:

- 1 boiler man heating asphalt.
- 1 conveyor operator unloading aggregates from cars and loading trucks.
- 3 truck drivers (part time only).
- 1 bituminous distributor driver.
- 1 bituminous distributor operator.
- 1 roller operator.
- 1 service truck and power broom driver.
- 1 tractor operator.
- 1 grader operator.
- 4 hand laborers.
- 1 foreman.

Seal Coat Crew:

Same as cover coat crew, except for the addition of 2 men on chip spreader, and the omission of tractor operator and grader man.

Principal Equipment:

- 1 20-H.P. Boiler to heat tank cars.
- 1 Burch conveyor to handle aggregates.
- 3 1½-ton aggregate trucks.
- 1 1½-ton service truck.
- 1 Detroit power broom with 5½-ft. roll.
- 1 1-bag Rex concrete mixer.
- 1 800-gal. Etnyre bituminous distributor.
- 1 60-H.P. Caterpillar tractor.
- 1 Adams grader with 12-ft. blade.
- 1 Buffalo-Springfield 5-ton tandem roller.
- 1 Buckeye chip spreader.
- 1 Homemade broom drag 16 ft. x 18 ft. with staggered rows.

Results and Expectations

On driving over these streets in November, I found them surprisingly smooth, and except for a stretch on Jones St. which had been subjected to an extraordinary steel-tired traffic, they appeared completely satisfactory. While canny engineers will withhold comment until the job has passed through the winter and spring trial, it is fair to say that present indications point to a distinct success.

Engineer Collins believes that another seal coat will be necessary in 1939 or 1940, and so informed Mayor Goldstein before awarding the contract. Such a coat, properly applied, would correct any minor damage or deterioration occurring in the meantime, would have a further evening effect, and would add about 3/8 in. to the average thickness. It would be completely in line with the "continuous maintenance" practice which has proved highly efficient in various small and medium sized towns, and which has been described in previous issues of *Roads and Streets*.

The Jones St. condition mentioned above resulted from the hauling of exceedingly heavy trailer loads of corn to

the plant of the Milford Canning Company, said to be the world's largest corn cannery. This hauling with steel tired trailers began two weeks after the surface was finished, and continued in large volume for about 8 weeks. It left a slightly indented track, but did not break or peel the surface, and in any case is limited to the minor damage class. While such injury may be unavoidable so long as heavy hauling with steel tires continues, it seems probable that it will at least be less after a longer curing and hardening period.



Michigan Construction Turns Up Relics of Seventy-Year Old Road

Engineers of the Michigan State Highway Department were surprised and impressed when they dug up about a mile and a half of aged planks recently as they proceeded with construction on US-16 between Webberville and Fowlerville. Investigation revealed that the planks were a part of the old toll road between Detroit and Lansing built back in 1867. The old road followed almost the same route as US-16 today. It was found that the road had been constructed of (1) hand-hewn logs laid side by side on muck soil, (2) dirt piled on the logs, (3) more logs laid on the dirt, (4) more dirt on the second layer of logs, and (5) planks laid on the second layer of dirt.

The old plank road was just wide enough for one wagon. Privately owned, the road was made to pay its way with tolls. Toll gates were established at several places along the line. The village of Novi today owes its name to the fact that Toll Gate No. VI was located there. By 1880 the planks began to rot. This type of construction gave way to gravel and by 1885 the road was taken over by the townships.



Transportation Maps Available for 13 States

Large-scale maps showing all details of the existing transportation system in 13 States have been prepared by the Bureau of Public Roads of the U. S. Department of Agriculture in cooperation with the U. S. Geological Survey. The maps are on a scale of four miles to the inch and are believed to be the most complete of the kind yet made. They are produced on sheets of uniform 26 by 36 in. size.

The maps show in color the location and character of practically all transportation arteries such as the federal-aid and state highway systems, important secondary highway connections, air lanes and landing fields, railroads, and navigable channels and canals, thus indicating on one map all the transportation facilities in the state.

The type or character of pavement on each federal-aid or state highway as of the date of the maps is shown by appropriate symbol. The maps also show the location of all federal and state areas and the roads leading to them. The maps, however, are too large to be used conveniently for touring.

The maps are obtainable by purchase from the Superintendent of Documents, Washington, D. C., at 20 cents a sheet.

DEFINITIONS FOR PARTS OF ROADWAY STRUCTURE

By HENRY C. PORTER

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IN STUDYING and discussing highway soil stabilization, there is often misunderstanding because of lack of established terms for different parts of the roadway structure. No doubt, before the desired results are obtained in highway design, all the soil must be relatively stable, even to the natural ground upon which the man-made part of the structure is placed. Often a method or process is practical for stabilizing the top few inches of the depth of the roadway, but it is not practical for all the soils of high embankments. Different methods must therefore be employed for different parts of the roadway structure.

The word "subgrade" as now generally used is indefinite. It may refer to a prepared surface, or it may refer to a layer or stratum next under the upper-most principal one, with no limit as to depth.

Although soil is probably the oldest building material, the stabilizing of it in the roadway structure is comparatively new. It is rather complicated, and is now being intensively studied, discussed and written about by highway engineers and scientists. There is no doubt but that the establishing of definite terms and definitions for the different parts of the roadway structure will expedite the solving of many different problems of roadway stabilization.

In order to stimulate interest in and discussion of this phase of the work, the following terms and definitions are offered as a working basis toward a solution:

Natural-Soil Foundation—The undisturbed soil upon which the soil-substructure, the subbase, the base, or the wearing-surface placed directly thereon, depends for its support.

Soil-Substructure—Made fills and embankments of disturbed soil placed on the natural-soil foundation (regardless of whether or not the fills are of selected soils).

Subbase—That part of the natural-soil foundation, or of the soil-substructure which receives treatment or preparation different from the remainder thereof, and upon which both a base and wearing-surface, of different designs, are placed; or any material placed on the top of the natural-soil foundations, or placed upon the top of the soil-substructure, of different types or with different methods of placing, and upon which both a base and a wearing-surface of different designs are placed.

Examples:

1. That part of the upper portion of the natural-soil foundation which is treated with oils, chemicals, water, etc., by permeation without rupturing the natural structure of the soil; or that part of the upper portion of the soil-substructure which is treated with oil, chemicals, water, asphalt, tar, cement, etc., either by permeation, or by scarifying and admixing, and upon which both a base and a wearing-surface of different designs are placed.
2. A layer of sand-clay, caliche, sand, gravel, crushed stone, etc., placed on top of a natural clay soil foundation or on top of a clay soil-substructure, and upon which both a base and a wearing-surface of different designs are placed.

Base—Any construction different from and placed directly upon the natural-soil foundation, the soil-substructure or

the subbase, and upon which a wearing-surface of different design is placed.

Example:

When a monolithic concrete slab is covered with bituminous material, the concrete is the base, and the bituminous material is the wearing surface.

Wearing-Surface—That part of the highway structure which comes directly in contact with and receives the wear of the traffic.

Example:

A 6 in. to 10 in. depth monolithic concrete slab is the wearing-surface of the highway when its surface receives directly the wear of the traffic; when macadam is covered with bituminous material which is subjected to the wear of the traffic, then the bituminous material is the wearing-surface and the macadam is the base.

Pavement—The wearing-surface, or the wearing-surface with its base, depending on the types as above described.

Example:

1. A concrete slab laid directly on the soil-substructure or on a base of specially treated or selected soil, is the pavement when its surface receives directly the wear of traffic;
2. When the concrete slab (or when macadam) is covered with a bituminous wearing-surface, the two together constitute the pavement.

Riding Qualities—The degree of smoothness furnished by the road structure to the traveling public while passing over it.

Stabilizing Process—Any artificial work applied to any part of the natural-soil foundation, or to any part of the soil-substructure or to the superstructure, to promote permanent subsequent non-change in its position, its volume, and its shape.

Examples:

1. The proper selecting and placing of pervious non-expansive and non-plastic soils and of highly expansive and plastic soils, with relation to one another in the road structure, to facilitate drainage and protection of the highly expansive and plastic soils from being excessively wetted by rainwater, and from excessive loss of moisture during droughts;
2. The building of the soil-substructure in thin layers and the blading of each layer sufficiently to break up all nesting of different soil types to obtain homogeneity of the soil throughout the layer, or gradual longitudinal transition from soil of one type to that of another in the layer;
3. The wetting of the entire soil structure when completed, by natural permeation of water ponded on top of it, to expedite the time of slaking of all clods in the soil structure, and the bringing of it as nearly as is practical to its average subsequent density;
4. The maintaining, true to line and grade, of the surface of the completed natural-soil foundation or the soil structure, in order that depressions will not form to impound rainwater which will cause non-uniform action in the soil structure, and in order that the weathered soil need not require reshaping and disturbing for the receiving of the superstructure;
5. The bringing of the natural-soil foundation or the soil structure to its average subsequent volume by placing its approximate average subsequent moisture in it immediately before the superstructure or any part thereof is placed;

6. The mixing of clay with sand at the top of the soil structure to provide better riding service during dry weather; and vice versa;
7. The admixing of chemicals, oil, asphalt, or cement, etc., with a soil.

Preservative—Any treatment or material applied to the upper portion or to the top of the natural-soil foundation, the soil-substructure, the subbase, or the base, which renders it temporarily serviceable as a riding surface.

Example:

A chemical or oil treatment, or a thin bituminous mat applied to clay, sand-clay, caliche, bound gravel, macadam, etc., to prevent or retard raveling and dust while the road structure is weathering under traffic on a "stage construction" project.

Stage Construction—The building of a highway by stages, as the constructing of the substructure in one year, and the constructing of the subbase, the base, or the wearing-surface at a later date or dates, in order to allow time for the substructure, subbase, and base to weather.

(When stage construction is employed, the riding-surface may eventually become the base or the subbase, or the base may become the subbase, as the work of building the highway progresses to completion.)

Weathering—The exposure of the natural-soil foundation, the soil-substructure, the subbase, and the base to natural stabilization by the action of the elements thereon (with proper maintenance) before the placing of the final wearing-surface.

Traffic Stabilization—The exposing of the natural-soil foundation, the soil-substructure, the subbase, or the base to the action of traffic.

Grade—(Webster's Dictionary, 1936 Ed.)

- (a) The rate of ascent or descent; gradient; deviation from a level surface to an inclined plane, as so many feet per 100 feet (a 10% grade is 10 feet change in elevation per 100 feet of horizontal distance);
- (b) A graded ascending, descending, or level portion of a road; a gradient;
- (c) (Railroad) The upper surface of a roadbed foundation.

Grade Line—(Webster's Dictionary, 1936 Ed.)

The longitudinal reference line or slope to which a highway or railway is built.

Subgrade—(Webster's Dictionary, 1936 Ed.)

A subgrade layer, a stratum, a surface; a layer next under the uppermost principal one; the surface of earth or rock leveled off to receive the foundation of a road, pavement, building, sewer, or other structure, or the ballast of a railroad.

In dealing with highway soil-stabilization work, the use of the word "subgrade" as above described and generally used, is indefinite. It may mean the prepared surface of a layer of material, or it may pertain to the entire underlying stratum or layer. If used, it should be stated just what part of the highway structure is meant. The use of foreign admixtures for stabilizing soils may be practical for application to "the surface of the earth leveled off to receive the foundation of the road" or for treating the underlying few inches of soil, but those methods of stabilizing may be impractical for treating the entire depth of a 15 ft. embankment or a peat bog when it comprises the "layer next under the uppermost principal one." In order to be specific the word is used in this discussion only as follows:

Subgrade—(Revised) The surface of earth, rock, or other material prepared to receive any part of the highway structure placed directly thereon.

Examples:

1. The subgrade of the soil-substructure is the surface of the natural-soil foundation prepared to receive the soil-substructure;
2. The subgrade of the subbase is the surface of the natural-soil foundation or of the soil-substructure prepared to receive the subbase;
3. The subgrade of the base is the surface of the natural-soil foundation, the soil-substructure, or of the subbase prepared to receive the base;
4. The subgrade of the wearing-surface is the surface of any of the above named parts of the roadway prepared to receive the wearing-surface.

World Registrations of Motor Vehicles

World registrations of automobiles, trucks and buses in 1936 reached an all-time record total of 40,560,167, according to *Automotive World News*, a publication of the U. S. Bureau of Foreign and Domestic Commerce. This figure represented a gain of 3,105,358 or 8.2 percent as compared with the total of the previous year. In the United States the registration improvement was 2,138,238 motor vehicles, a percentage advance of 8.1 percent over Jan. 1, 1936. The demand existing in other countries of the world accounted for the use of 967,120 or 8.7 percent more units than were reported in operation just twelve months previous.

The ratio of automobiles to population during 1936 is placed at 1 to 54 throughout the world, or approximately the same relation as was recorded for 1935. Excluding the United States the ratio is 1 to 173 persons, as compared with 1 to 173 a year ago. The per capita ownership in the United States was 1 to 4.5 as against 1 to 4.8 in 1935. Hawaii and New Zealand each accounted for one motor vehicle to every seven inhabitants, with Canada reporting 1 to every 9 persons. On the other hand we find that China has but 1 vehicle for every 10,000 persons; Liberia 1 to every 20,000 inhabitants, and Yemen has a population of 28,295, for every motor car registered at the close of 1936.

Following the United States in the number of motor vehicles registered was the United Kingdom with 2,241,680; France was in third position with 2,167,018, Germany fourth with 1,370,362, Canada occupied fifth place with 1,234,071, followed by Australia with 696,578. These identical countries were the leaders in 1935, but France was then in second place and Canada was placed ahead of Germany in the fourth position. Substantial increases in the number of motor vehicles in use are recorded in each of the countries mentioned.

England's First Autostrada

Plans for England's first "autostrada"—a road designed exclusively for motor traffic—have been approved by the Lancashire County Council. The scheme is for a 54 mile trunk road running north and south through Lancashire. It will by-pass four towns, Carnforth, Lancaster, Preston and Wigan, bridge the rivers Lune and Ribble and the Manchester Ship Canal, and besides expediting motor traffic will relieve congestion and promote greater safety on the roads. The cost is estimated at between \$25,000,000 and \$30,000,000, and the necessary steps are being taken to secure the sanction of the Government to the scheme. The authorities in Cheshire and Westmoreland are also to be approached with a view to linking up their areas with the scheme and so provide a new and perfect "Great North Road" on the western side of the Pennines. The Lancashire scheme will take about three years.

INDIANA NOW REQUIRES CONTRACTOR PREQUALIFICATION.—The State Highway Commission of Indiana now requires advance qualification of bidders on state highway construction and maintenance projects. The new prequalification requirement replaces the former financial statement which was required of bidders.



Shovel Serving Trucks in Grading Montana Road

THE MANAGEMENT OF HIGHWAY GRADING

The Fourth of a Series of Articles Dealing With Its Economic Aspects

By J. L. HARRISON

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Chapter 4. Calculating the Hauling Equipment for the Job

THE preceding chapter deals with the determination of the amount of hauling equipment that is required to get the diggings to a given fill efficiently. In that discussion it was pointed out that layer dumping makes the whole fill area available for the disposition of the diggings—a very important matter from the standpoint of efficiency in operation because it enables the contractor, by simply dumping at several points on the fill rather than at a single point, to maintain an almost perfect balance between his digging operation and his hauling operation whenever he is in a position so to equip the hauling operation that it is in balance with the digging unit at the average haul to the dump on which work is being performed. Whether the job superintendent will be in a position to do this accurately will depend on the information he is provided as to the average haul distances the various fills on his job involve and on how the job has been equipped.

As to calculating the average haul distance any particular cut involves, nothing need be said here, as it is a problem on which valuable light can be thrown only by rather detailed discussion with little prospect that, even were such a discussion attempted, anything of material value could be added to the information standard textbooks contain. But, whether the job has been properly equipped—or rather how to determine that it is properly

equipped—is important here and some comment on it seems warranted.

Determining If Job Is Properly Equipped

As a basis for this discussion it will be assumed that a succession of cuts and fills is involved. In practice there may also be some casting and some borrow, but these operations will not greatly affect the final conclusions unless they cover a major fraction of the work to be done, in which case they should be added to the study which otherwise may be confined to an analysis of average haul to the various fills the project involves.

For purposes of illustration it may be assumed that the project is made up of three fills taken from four cuts and that, as the project has been designed and balanced out, the three fills, as would usually be the case, comprise six balanced fill sections with average haul distances, etc., as follows:

Fill No.	Average Haul Distance	Yardage	*No. of Hauling Units Required
1	600 feet	11,000	4
2	400 feet	4,000	3
3	1,100 feet	9,000	5
4	700 feet	12,000	4
5	800 feet	5,000	5
6	500 feet	7,000	4
		48,000	

*See next table for determination.

Assume that a $1\frac{1}{4}$ -yard shovel (0.9 cu. yd. per dipperful) and tractor-drawn wagons (8 dipperfuls per wagon) are to be used. The constant loading time ($2\frac{2}{3}$ minutes) plus getting under the shovel and dumping (2 minutes) make a probable constant time per load, over and above hauling time, of $4\frac{2}{3}$ minutes or say 5 minutes. Hauling time at 250 feet per minute—a safe tractor speed (somewhat higher speeds are rather generally used)—is then 4.8 minutes for the 600-foot haul, 3.2 minutes for the 400-foot haul, 8.8 minutes for the 1100-foot haul, etc. We then have the following sub-table:

Fill No.	Haul Distance Ft.	Constant Time Required For Turning, Loading, etc. Min.	Average Hauling Time Min.	Round Trip Time Per Load Min.	Loads Per Hour Each Wagon Will Haul	Loads Shovel Will Load Per Hour	Wagons Required to Maintain Full Production at Shovel	Wagons To Be Sent Out To Work
1	600	5	4.8	9.8	6.0	22.2	3.7	4
2	400	5	3.2	8.2	7.3	22.2	3.0	3
3	1100	5	8.8	13.8	4.3	22.2	5.0	5
4	700	5	5.6	10.6	5.6	22.2	4.0	4
5	800	5	6.4	11.4	5.2	22.2	4.3	5
6	500	5	4.0	9.0	6.7	22.2	3.3	4

Now it is evident from the last column of this table that on one of these fills only three wagons are needed, that on three of them four wagons are required and that on two, five would be desirable. The question that then naturally arises is, "How many wagons should be placed at the disposal of the Job Superintendent?" The calculations indicated in the following table throw valuable light on this matter:

*The modern tractor, used on work of this sort, has more than one gear in which hauling can be done. Ground conditions and other conditions determine the usual operating speed.

Cut No.	Wagons Required For Full Production	Lost Time if 3 Wagons Are Provided		Lost Time if 4 Wagons Are Provided		Lost Time if 5 Wagons Are Provided	
		By Wagons	By Shovel	By Wagons A	By Shovel B	By Wagons A	By Shovel B
1	3.7	0	19%	0	7%	0	20%
2	3.0	0	0	25%	0	0	40%
3	5.0	0	40%	0	0	20%	0
4	4.0	0	25%	0	0	0	20%
5	4.3	0	30%	0	0	7%	0
6	3.3	0	9%	0	17%	0	20%

Weighted Averages 22.5% 2% 4% 4.3% 14% 5% 0
 A. Time lost idle in yard
 B. Time lost due to under utilization while at work on the job

The Matter of Hauling Units

Now under any given circumstances it may be assumed that the contractor will know the relative capital value and operating cost of the various pieces of equipment he uses and, therefore, that he need make no assumptions at this point. However, as we are here dealing with a hypothetical situation, it will be assumed that the shovel is worth twice as much as one of the tractor-wagon hauling units and that it costs twice as much to operate it. It will also be assumed that a hauling unit idle in the yard costs the contractor only half as much as a hauling unit idle (time not fully used while working) on the job. Both of these assumptions are, as a matter of fact, reasonably accurate.

Under these assumptions it is clear that if only three wagons are sent to the job $\frac{3}{5}$ of the investment is in the wagons (with their tractors) and $\frac{2}{5}$ or 40 per cent is in the shovel. As the shovel will be working 22.5 per cent under capacity it is evident that production will be only 77.5 per cent of what it would be if the shovel could be kept busy. The effect of this underproduction is to increase all job unit costs, except the cost of hauling on which the units are, under these assumptions, working at

capacity, about 30 per cent. Unit production cost, including hauling cost, will then be nearly 20 per cent above the theoretical minimum for the type outfit that is being used.

If four wagons are provided, probable production at the shovel jumps from 77.5 per cent to a little over 95 per cent. Job unit costs (except hauling cost) are now only 5 per cent above the theoretical minimum. Hauling costs, however, have risen about 6 per cent by reason of now, for some of the time, using a little surplus hauling equipment on the work and having one unit idle for a short time. In short, having four wagons available, all of which will be used except for one idle unit while fill No. 2 is being put in, produces a job cost that is now only a little more than 5 per cent above the theoretical minimum.

If five wagons are sent out no time need be lost by the shovel. Unit costs on all operations except hauling are, then, held at a minimum. However, if five wagons are provided, hauling costs are increased by about 5 per cent due to having extra hauling units at work and (under an assumption that an idle unit costs about half as much as lost time while a unit is at work), by about 7 per cent by reason of units at times held idle at the equipment depot. In gross, then, the cost of hauling is increased by 12 per cent if five wagons are sent to the job. These comments may be summarized as follows:

	Percentages of Full Production	Hauling Unit Cost	Digging and Loading, Dump and Other Job Unit Costs
With 3 wagon outfit	77.5	100%	130%
With 4 wagon outfit	95	105%	105%
With 5 wagon outfit	100	112%	100%

Whether the four wagon outfit or the five wagon outfit is likely to yield the better results will, of course, depend on the ratio of hauling costs to other job costs. If hauling costs are 50 per cent of total job costs, the effect of sending out a five wagon outfit is to establish a probable unit production cost of 106 per cent of the theoretical minimum as compared with a probable unit production cost of a little over 105 per cent of the theoretical minimum if a four wagon outfit is used. On the other hand, if hauling will account for only 40 per cent of job production cost, the five wagon outfit is very slightly the more economical.

If this analysis had been run out for a larger shovel and these tractor-drawn wagons or similar wagons using their own power, or for this same shovel and trucks, it would almost always appear, as in this case, that the most economical tooling has been reached when enough hauling equipment has been provided to keep the shovel busy about 95 per cent of the time. This is pretty certain to mean that during a good deal of the time the hauling side of the work will be little over-equipped and that at times a little idle equipment will be held in the yard. This is not a bad thing. Indeed as a rule it is desirable as, otherwise, if a hauling unit breaks down there is a loss of production at the shovel until it is repaired. Inevitably this is expensive.

The calculations outlined above are easily made and throw so much light on how the particular job should be equipped that it would be desirable to make them for every grading job. Much under-equipment of the hauling operation would be avoided if this were done. The em-



Loading Gravel Topping in Pit in Oregon

phasis is placed on under-equipment! Calculations of this sort would, of course, be equally effective in avoiding over-equipment. However, as the writer has yet to see the first grading job on which too much hauling equipment was in use, the need for caution against over-tooling the hauling side of the work does not appear to him to be very great.

It may be observed again at this point that such time factors as turning time, travel speed, loading at the shovel, etc., vary a good deal. The above statement covers a practical method of determining how a particular job should be equipped. If accurate results are to be obtained each contractor should determine these time factors on his own jobs and should require that this be done with some accuracy. This can be done by timing them on going projects which, after all, is rather a simple matter. With only a little experience they can be determined with quite sufficient accuracy by reading and recording the time involved in each of them from an ordinary watch, the second hand being used in reading the shorter operations. The determinations so made, rather than those used above, should be used when tooling studies are being made.

In addition to providing information necessary in calculating the amount of equipment—particularly hauling equipment—that is to be sent to the job, time studies serve to focus attention on time losses that are occurring on the job. Many of these are apt to seem small. In fact they are small. But if they occur several times an hour, day after day, their cumulative effect is pretty certain to be important from the production standpoint and from the standpoint of the effect production has on unit cost.

How Production Was Increased on Scraper Job

The writer will remember a slip scraper job studied ten years ago on which this fact was clearly illustrated. The teams were working on a short haul, the round trip taking a little over a minute—some 50 round trips per team per hour being the average on that particular day. The contractor complained that he was not getting the production he should and that he was losing money. In response to his inquiry as to whether there was any reason for this low production his attention was called to the fact that it had become the practice on this job to stop each team after the slip had been dumped, while one of the men turned it back, and to stop it again to permit the man who loaded the slips to take a good hold

on the handles. It was indicated that if these altogether needless stops were eliminated his production would be increased. He opined that the time lost in this way was too small to be worth worrying about. Still, being an open minded chap, he was willing to give the idea a trial. It increased production more than 20 per cent and converted a losing job into a modestly profitable one. But the important thing here is not the effect on this particular job but the fact that the loss of a few seconds seemed a trifling thing. It had not been appreciated that each of some seven or eight teams were losing these trifles of time more than one thousand times a day and doing this day after day. The "few seconds" a single stop took didn't matter much. That was true enough. But taking this loss a thousand times in a day made it a very different matter. This man, like any other man in his position, would have discharged any employee he had ever had who would "knock off" whenever he pleased to take a few drags on a cigarette. Yet the fact remains that such a man might easily have been putting in more time every day than some other man who stopped for a few seconds every few minutes.

It is the same with other operations. When one is stopped for half an hour it clearly involves a loss. But if there is a minute's delay here and a minute's delay there their cumulative effect may easily be overlooked. Time studies are a bit monotonous. They take time. But, in so far as they serve to rivet attention on the value of time and the importance of making use of it, they are more than well worth while.

Finally, as to the determination of the hauling units to be sent to the job, it may be remarked that calculating the number of hauling units for an elevating grader outfit differs in no essential particular from calculating the number of hauling units to be used with a shovel. Some of the time factors, loading time in particular, are a little different. The ratio of the cost of digging and loading to the cost of hauling is quite different. Fundamentally, the calculations are otherwise the same for both types of outfits. However, it is not inappropriate to remark again that, as the cost of the digging and loading unit and the cost of operating it is not very different from the cost of a large tractor-drawn wagon—the hauling unit quite generally used on work of this sort—and the cost of



Loading Earth in Trucks on Blue Ridge Parkway in North Carolina

operating it, it is better practice in elevating grader work to have the grader idle part of the time than to maintain surplus hauling equipment on the job. The ideal, of course, is a close balance between digging capacity and hauling capacity, but if the outfit cannot be kept in balance it is better to have a little less hauling equipment than is theoretically required. In this respect the situation is different than it is on power shovel jobs where it may be accepted as good practice to have a little more hauling equipment than is required to keep the outfit in balance.

Balanced Tooling and Profits

These comments are based on observations and deductions that have been made in this and in the preceding article. However, their importance is greater than previous comment may have suggested for the development of a balanced tooling on a power shovel job and also on an elevating grader job is by no means merely a matter of serving some idea of theoretical value. Rather it is a matter of good hard dollars and cents on the profit side of the ledger. On the job the shovel, once under way, generates a pretty constant cost per day. The same is true of the elevating grader. The cost of operating the shovel outfit is, say, \$150.00 a day. It may be a good deal more than this. This cost covers (1) the shovel and the men who work with it, (2) hauling, (3) work done on the dump and (4) supervision. Now it is perfectly apparent that (1) costs on and around the shovel, (3) costs on the dump and (4) supervision, are constant and remain so whether the production is large or small. The ratio of this part of the daily cost of operation (set down above for purposes of illustrating as \$150.00) to the whole daily cost of operation varies a great deal, but we may assume it to be one-half, that is, that \$75.00 out of the total daily cost of operation is generated by the shovel, the dump and the supervision. It is, of course, evident that as long as the daily cost of operation is \$150.00 the unit cost of production will vary with the amount produced. That is, if 750 cu. yd. a day are produced, the unit cost of production is 20c. If 600 cu. yd. are produced, the cost is 25c. If production falls to 500 cu. yd., unit cost rises to 30c. In short, low production and high unit cost go together. But this is by no means a complete statement of the case. It has been remarked above that about half of the daily cost of production is fixed. The other half is subject to variation by the addition or subtraction of hauling units. If the hauling units generate a cost of \$15.00 a day, and five are in use, a drop in production to 500 yd. per day would suggest the need of a couple of additional hauling units. These being added, the daily cost of operation rises to \$180.00 a day, but as production returns to 750 yd. a day unit cost is reduced from 30c to 24c. In short, though the cost of hauling is increased, the increase in the production brings the effect of the fixed costs on unit cost back to normal.

The Effect of Fixed Costs

These rather simple illustrations serve to lay a much needed emphasis on three facts—(1) that a large part of the daily cost of operating a shovel outfit is fixed, (2) that the effect of this fixed cost on unit costs is directly dependent on production, and (3) that the effect of this

fixed cost on unit cost is so great that production must be kept as close to top capacity as possible if unit costs are to be kept within reason.

This is why so much has been said of proper tooling, of keeping operations in balance, of an adequate amount of hauling equipment. The objective is to keep production up to keep the influence of the fixed fraction of daily operating cost as low as possible. On a shovel job fixed costs always are high. That is innate in this sort of work. But by keeping production up their influence on unit production cost can be kept within reasonable limits. That is the objective and where, by good management, this is done, the results are pretty certain to be satisfactory. On the other hand the penalty for not keeping up production is very severe. If fixed costs are \$75.00 a day and production is 750 cu. yd., they generate a unit cost of 10c. At 500 cu. yd. a day they generate a unit cost of 15c. At 375 cu. yd. a day they generate a unit cost of 20c a day. The writer has seen a good many jobs on which the relation between fixed costs and production was such that the fixed costs (as this term is here used) were generating more than 20c a day. Usually this is more than twice what they should generate. Margins of profit are not wide enough to cover excesses of this sort.

In the above comments it has been assumed that the hauling units are efficiently operated and that production can be kept up by adding hauling units. As a rule this is the case. Still, in practice, lax management is pretty likely to affect all parts of the work and when it does, while adding hauling units will help, more far reaching changes may be needed. The under-loading of hauling units is not uncommon on shovel jobs. It is usually the result of allowing the shovel operator to put a fixed number of dipper loads on each hauling unit. He should be required to send out a full load, particularly when there are not enough trucks to keep the shovel busy.

Sometimes there is a good deal of loafing along the road. A "smart" driver can kill a great deal of time on the road, particularly when hauling conditions are bad. He can also kill time on the dump. The solution is, as far as possible, to keep the roads over which hauling must be done in good condition and to get rid of drivers who cannot maintain a proper schedule.

In this, as in other types of construction work, the objective is profit. What has been suggested above has been suggested with one thought in mind—that a balanced tooling is necessary if high production is to be consistently maintained. Profit and high production are closely related. The desirability of maintaining a high rate of production and, therefore, the need of keeping shovel and elevating grader outfits in balance throughout, needs no other emphasis than this.



KENTUCKY ROAD SCHOOL POSTPONED—The University of Kentucky Road and Street School scheduled for Dec. 6, 7, 8, and 9th, 1937, at the College of Engineering, Lexington, Kentucky, was indefinitely postponed until the building program of the engineering department has been completed, in order that enough space will be available for the exhibits in connection with the school.

THE THEORY OF AIR MOVEMENTS AND "POLAR FRONTS"

By HALBERT P. GILLETTE

ABOUT 17 years ago, Bjerknes of Norway, published papers showing "that warm winds converging toward colder winds rise above the colder air and their moisture is condensed in the same way as in the air rising over mountain summits." This was the beginning of what has become a great volume of literature on "polar fronts" and "air mass analysis." Bjerknes certainly has the credit of greatly developing a theory that Shaw and others had initiated; but his attempts to explain the movements of air-masses are not at all satisfactory. Particularly weak in his explanation of the small cyclonic whirls along the "fronts." He sees in them eddies resulting from oppositely moving currents of air. The eddy theory of air-whirls is a very old one, and one that is quite plausible as to certain small cyclones, but it fails to explain the descending whirls called anticyclones, and it fails just as signally to explain both the very large "permanent cyclones" and the very small, violent cyclones called tornadoes.

A theory that explains one particular type of phenomenon but fails to explain other types is always open to suspicion; such a theory is the eddy theory of air whirls.

Nearly a century ago, Faraday discovered that an electric current in a magnetic field tends to rotate. He also discovered that many gases are magnetic, and that oxygen is the most magnetic of all gases, bearing the same magnetic relation to other gases that iron bears to other solids. Let us "put two and two together." The earth is a magnet and it is constantly emitting electrons. Applying Faraday's principle, we see that these ascending electrons must rotate cyclonically; that is, counter-clockwise in the northern hemisphere and clockwise in the southern hemisphere. These are the directions of rotation of all cyclonic air, whether in the vast permanent cyclone of the Aleutian Islands region having a diameter measured in hundreds of miles, or in the minute but mighty tornado a few hundred feet across.

Let a whirl of electrons once start in the air, and it tends to grow in intensity because it magnetizes the oxygen inside the whirl. The oxygen takes the place of the iron-core of an electromagnet. But when the oxygen becomes magnetized, more electrons are attracted magnetically from the surrounding air, and join the whirl. Since electrons moving in the same general direction attract one another magnetically, there is not only a flow of electrons from without, but from within toward the electron-whirl that forms a hollow cylinder. This causes the low barometer near the center of all cyclones.

Since "what goes up must come down," the air that ascends in one region descends in another. But descending air charged with electrons must whirl counterclockwise, according to the Faraday principle; and as it is entering denser air below, the pressure rises and an outward flow of air occurs. If air pressure were the only cause of air motion, nearly all the air from an anticyclone

should flow directly toward the nearest cyclone. This does not occur as I see it; what happens is this: The electrons emitted near the base of an anticyclone flow away laterally in all directions, carrying air with them for a long distance. Then they begin to ascend, and when that occurs they must move eastward in both northern and southern hemispheres, for the Faraday principle of magnetic rotation makes such a current imperative. In attempting to flow eastward those in the rear of the anticyclone are forced to travel around its southern perimeter, for they are repelled both electrically and magnetically by the electrons descending in the anticyclone. The consequence is that on the eastern front of the descending anticyclone the number of ascending electrons is greatest. Since increase in electron density is favorable to the development of magnetically rotated cyclones, the latter tend to form along the eastern front of every great anticyclone. We have "polar air" on the eastern front of an anticyclone, meeting the "tropical air" of the cyclone whose rotation is counterclockwise. The cool air chills the warm air and rainfall is apt to occur along the "polar front." This would happen even if the warm cyclonic air were not ascending, but its ascent increases the precipitation.

Many of the ascending electrons of the cyclone probably flow back into the anticyclone at a great elevation, far above the clouds, and thus aid in maintaining the anticyclone.

Clayton has spoken of the very puzzling "cross-currents" in front of an advancing mass of descending air which he mistakenly speaks of as a "wave." It is never a wave and always a whirl. He says: "Another disturbing factor is the formation of centers of disturbance (cyclones) moving at right angles to the normal waves (anticyclones). When waves of high pressure and low temperature (anticyclones) are advancing from the northwest, low pressure areas (cyclones) form in front of them and advance southwest to northeast." (Words in parenthesis are mine.)

Generally accepted theory gives no explanation of the southeast movement of an anticyclone across whose front a series of cyclones moves northeast. Small wonder that Clayton calls it "another disturbing factor." But if we regard these air-whirls as magnets, much of the trouble disappears, for they have opposite magnetic polarity.

The generally accepted theory is that migrating air-whirls are carried along in the general air current, like spinning eddies in a river. But the theory breaks down when two contiguous eddies are moving at right angles. In fact, it bogs down repeatedly. Not infrequently the center of a migrating cyclone describes a great loop, yet the general air current does not loop. In the eastern part of America, the common trend of anticyclones is toward the southeast, whereas that of cyclones is toward the northeast. One cyclone has been traced clear around

the earth, re-entering America not far from where it started about a month previously. Yet every book on meteorology that I have read attributes the eastward trend of air in temperate latitudes to a northward flow of air whose inertia carries it eastward as it reaches higher latitudes. This would inevitably prevent a cyclone from circling the globe and returning to about the place where it started.

If the west to east flow of air in temperate and high latitudes is due to magnetic rotation of electrons constantly escaping from the earth, as above deduced from the Faraday principle, why is there an opposite flow of surface air in the tropics? The surface winds there are the trade winds moving westward, but above them are the anti-trades moving eastward and the latter fit our theory. The apparent exception is the tropical trades, but this is "the exception that proves the rule," for these trades also obey the Faraday principle. The lower air in the tropics carries a preponderant charge of protons—(or positive units); hence, upon ascending the protons are driven westward by the earth's magnetism, except at the magnetic equator where that propulsive force is nil.

The lower air contains two zones of oppositely charged air, namely the positively charged tropics and the negatively charged air in higher latitudes. Both zones contain both protons and electrons, but I am speaking of the preponderance in numbers of one over the other. This zonal segregation results from the fact that electrons and protons moving in the same direction repel one another magnetically, and if their velocity is sufficiently great their magnetic repulsion exceeds their electric attraction for one other. Electrons are emitted from the earth in numbers greatly exceeding the proton emission; and they tend to travel spirally around the earth's magnetic axis toward both poles, the number travelling northward apparently exceeding the number travelling southward. In addition, spiralling solar electrons are entering near both magnetic poles. Hence in high latitudes a great preponderance of electrons exist. Since they are carried around with the rotating earth, and since they attract one another magnetically, the electrons congregate in zones where the greater rotational velocity imparts greater magnetism to them. Where they are most congregated in these zones, there the air pressure must be greatest, for they carry air with them. The latitudes of greatest air pressure are 40 degrees. In the southern hemisphere where there is little land to reduce air currents, the greatest and most persistent winds are those of the roaring forties." Near "the forties" in America, we also have the most violent gales and the most frequent tornadoes. Furthermore, the most frequent and violent tornadoes occur near the meridian that passes through the magnetic north pole! All these are facts that the electron theory explains well, whereas the thermal-connection theory either offers a questionable explanation or none at all.

That the earth and sun are encased in electron-shells is, I think, beyond question. It seems likely that between some of these lower terrestrial electronospheres, there are protonospheres; for certain phenomena, notably lightning, are best explained if that is the case.

Speaking of the sun reminds me of last summer's discovery by Major A. W. Stevens that the sun's corona is a sphere whose diameter is double that of the sun. I infer that the corona is an electronosphere. Sometime ago I

suggested that the visible disk or photosphere is an electronosphere loaded with incandescent gases, and that the sun's core is a molten globe whose diameter is two-thirds that of the photosphere. I suggested two-thirds, for that would give it a density not much less than the earth's density. Although most astronomers believe the sun to be entirely gaseous, Sir James Jeans thinks its core and that of all other stars is molten.

Electron theory has revolutionized both physics and chemistry. Would it not be strange if it were to leave meteorology untouched?



National Paving Brick Association to Meet at Cincinnati

The thirty-second annual meeting of the National Paving Brick Association will be held at Cincinnati, O., Jan. 12, 13 and 14, 1938, at the Netherland Plaza Hotel. In addition to the business meetings many of the sessions will be open to the general public. Those interested in street and highway development are cordially invited to attend.

The program will include papers and discussions by prominent engineers and contractors experienced in the use of brick for paving purposes. Important recent developments in manufacturing, in the technique of testing and in construction practices will be considered. There will be descriptions of modern brick projects, such as the recent paving of the new Lincoln tunnel under the Hudson River in New York City. The Research Bureau, maintained by the National Paving Brick Association at the Ohio State University Experiment Station, will report on its year's activities including both laboratory and service investigations and studies. Increased skid-resistant properties for brick pavements as a result of the development of non-exuding filler materials and other important accomplishments of research will be discussed.

The relationship of the brick type of pavement to the highway problem of the present and future will be an important theme of the convention. This will involve the contribution that brick can make to highway safety; and its adaptability as a heavy duty type—with an unmatched record of past performance—to the express or limited traffic way era now in its early stages.

C. C. Blair, head of the Metropolitan Paving Brick Co. of Canton, O., is president and George F. Schlesinger, National Press Bldg., Washington D.C., is chief engineer and secretary of the National Paving Brick Association.



8-HOUR DRIVING DAY ON GERMAN SUPERHIGHWAYS—As a means of combatting one serious cause of accidents on the new superhighways of Germany an order is to be issued forbidding motorists to drive more than 8 hours without several hours rest.



25 ACRES IN AVERAGE CITY PARK—A nation-wide survey covering 10,000 individual areas completed recently by the National Park Service and the National Recreation Association, shows that the average American city park contains about 25 acres.

HIGHWAY CONSTRUCTION IN CALIFORNIA

Construction Progress and Pavement Records for 1936

By EARL WITHYCOMBE

*Assistant Construction Engineer, Division of Highways
State Department of Public Works*

THE outstanding feature in highway construction during the year 1936 was the preliminary treatment of subgrade, prior to the placing of pavement, particularly for asphalt concrete and portland cement concrete types. The improvement of both the foundation and the immediate subgrade is of primary importance, and too much emphasis cannot be placed on the most careful and scientific analysis and proper treatment of these factors in pavement construction. A brief description of the methods employed is given below.

Grading and Pavement Foundation

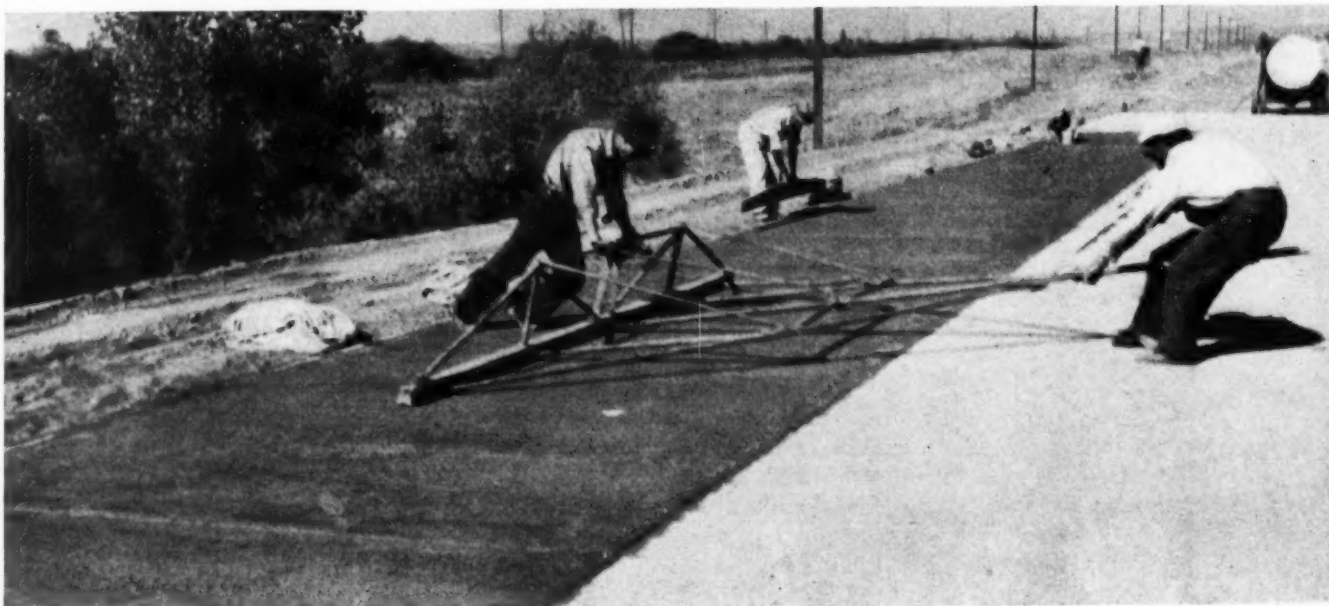
The roadway, which is identical to any other engineering structure, should rest on an unyielding foundation in order to secure best results. Insecure foundation conditions are largely the result of subsurface saturation, and wherever possible, areas which cannot be readily drained and corrected are avoided in the location stages of highway design. It becomes necessary, however, at times to construct pavements over isolated areas of this description, and by means of boring tests the extent of such instability is approximately determined. Once determined, it becomes a question of economics as to the proper method of correction. The methods used in California,

listed as to their feasibility and order of consideration, are as follows:

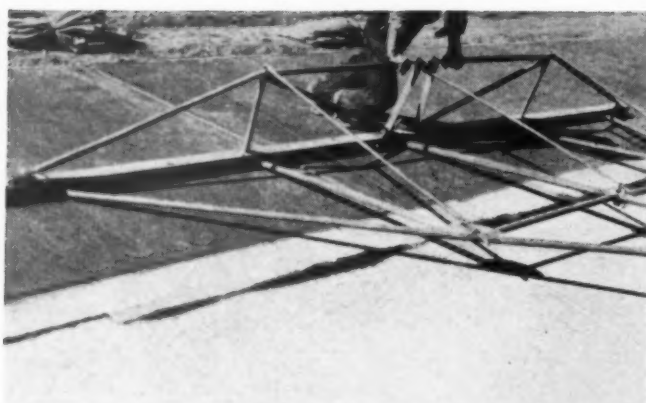
- (1) Dewatering by gravity flow induced by subsurface drains.
- (2) Removal and replacement of the unstable material.
- (3) Building of an embankment strut between the unstable mass and an adjacent stable geological structure.
- (4) Construction of a stable roadbed by means of a systematic overloading of the roadbed area to obtain displacement of underlying mud, and followed by removal of surplus overload to the planned elevation.
- (5) The construction of vertical drains for dewatering underlying muds.

The first four of these methods are in quite common use by highway engineers. It has become general practice in California construction to supplement methods (1) and (2), wherever rock is available, by excavating a toe trench to solid foundation on the lower side of the unstable area and backfilling with as coarse rock fragments as are available. This type of submerged gravity rock toe wall is particularly effective under a variety of conditions.

Method (5) is particularly worthy of description, as it is comparatively new and was originated by the Division



Steel-Shod Cut Float for Final Finish on Portland Cement Concrete Pavement



Close-up of Steel Shod Cut Float

of Highways. This method consists of sinking a large diameter well casing to the bottom of the unstable area and as the casing is removed, filling the hole with a porous and granular aggregate. The spacing of the vertical drains must necessarily be on rather close centers, which makes the method rather expensive. On the limited experimental sections constructed to date, it would appear that the rate of consolidation of the unstable material under the load of superimposed roadway is greatly accelerated, and if sufficient time can be permitted between the construction of the roadway and the final paving, distortion of the riding surface may be minimized. Lateral movement of the unstable area during consolidation, however, may decrease the effectiveness of this method, and reasonable care must be exercised in the construction. It is necessary to connect the tops of the vertical drains, by means of porous subdrains, to a convenient outlet.

Stabilization of Subgrades

Stabilizing of subgrades is generally accomplished with a blanket course of suitable material of sufficient depth to distribute the load to limits well under the maximum bearing power of the underlying materials. Where suitable blanket material is difficult to obtain, consideration is given as to incorporating an admixture with the native soil.

Even the most economical of foundation treatments is an expensive procedure and has resulted in considerably increased cost of construction. In general, however, the decrease in subsequent maintenance expenditures and the increased convenience to the traveling public have adequately justified the added expense.

Portland Cement Concrete

Construction Methods

The conventional methods of finishing were used throughout the 1936 season's work. Due to the difficulty in obtaining floatmen with experience, an effort was made to reduce the weight of finishing tools, especially the floats, to make them more workable by the average individual.

Joint Construction

All transverse joints are doweled with $\frac{3}{4}$ in. round steel bars on 14 in. centers. The only other steel used is the $\frac{1}{2}$ in. square reinforcing bar fixed by chairs driven into the subgrade to support each end of the dowels, and the longitudinal tie-bars at selected locations. Wherever subsequent movement was anticipated in high embankments, tie-bars were used across the longitudinal joint consisting

of $\frac{1}{2}$ in. square bars in longitudinal weakened plane joints, and threaded sleeve-connected $\frac{3}{4}$ in. bolts placed along longitudinal construction joints.

The joint interval was almost uniformly 20 ft., with provision made for $\frac{1}{2}$ in. expansion at each 60 ft. interval.

Mixtures

Considerable reduction in the cement content was undertaken during the past season. Forty-nine percent of the season's mileage was constructed of concrete with but five sacks to the cubic yard. Provision was made in the specifications to blend fine sand with the ordinary commercial product, but on only one job was this found necessary. These mixtures are somewhat harsh, but it was demonstrated during this season that excellent results could be obtained with such reductions in cement.

The vibration method of placing concrete was set up as an alternate method in the specifications, but no contractor has seen fit to avail himself of this opportunity. An attempt was made to substitute vibration along the side forms in lieu of spading by means of trailing individual units over the surface adjacent to the side forms, but this proved to be unsuccessful.

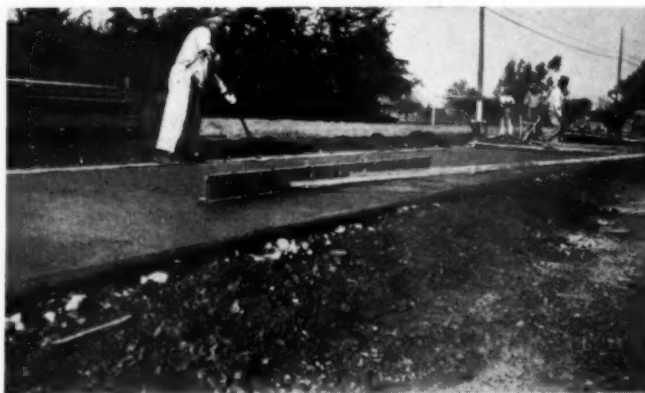
Construction Records

The maximum average daily output of portland cement concrete pavement, reduced to an 8-hour comparative basis, was placed in Solano County, from 1 mile north of Carquinez Bridge to Cordelia, 690 cu. yd. being produced by two pavers. The maximum output for one paver was 463 cu. yd. per day in Los Angeles County, from Seal Beach to Newport Beach. The average daily output for the State during 1936 was 385.7 cu. yd., compared to 343.3 cu. yd. in 1935.

The strongest concrete placed during 1936 was in Los Angeles County from Route 19 to Anaheim-Spadra Road, with an average compressive strength of 5570 lb.

Out of a total of 134,900 cu. yd. of concrete pavement laid, 69,270 cu. yd., or 51.3 per cent, was Class "A" mix, with an average strength of 4,550 lb., compared to 4,965 lb. in 1935. Four large pavement projects used 65,628 cu. yd. of Class "B" concrete, being 48.7 per cent of the total yardage placed, and having an average strength of 3,740 lb. at 28 days.

The record for cement control was made in Los Angeles County between Little Sycamore Canyon and Encinal Canyon, with an average variation of 0.44 per cent. The



16 Ft. Wooden Float on Portland Cement Concrete Pavement



Bump-Rolling Asphaltic Concrete Pavement

average variation for the State was 0.85 per cent compared to 0.93 per cent in 1935.

The record for surface smoothness was obtained in Los Angeles County from $\frac{1}{4}$ mile south of Kern County line to Fort Tejon, where the average roughness per mile was 4.9 in. During 1936, the smoothest and the roughest riding qualities were encountered on projects constructed with 5-sack concrete, which seems to indicate that especial care must be exercised with reduced cement content mixtures in order to get good results. With the elimination of one such Class "B" rough project, the average roughness for the year is reduced to 9.0 in. per mile, which is comparable with previous year's records of 9.3 in.

The excellent riding qualities of this type of pavement are obtained by the so-called delayed finish which consists of periodic floating of the surface, cutting and filling in the surface irregularities caused by uneven subsidence, up to the stage where no more settlement will be experienced, and finally cutting off the remaining high spots with a steel cut-float. The reason for this excessive floating is to keep the surface alive and workable while subsidence is taking place, and removing the irregularities by stages in order to reduce to a minimum the amount of work to be finally done with the steel float. The less work required with this cut-float, the more effective it will naturally be.

Two finishing machines are specified when the concrete output exceeds the recognized capacity of one mixer, with the alternative that a second "bull" float may be substituted for the second finishing machine. All floats are laid longitudinally with the pavement and operated to cut transversely across the pavement. The excess cut off is used to fill in irregularities on all floats except the final steel cut-float. The "bull" float is operated by one man on each end of the float, working from bridges spanning the pavement. Behind the "bull" floats are two 16 ft. cut-floats operated from the side of the pavement by a single central handle, and finally the 16 ft. steel bottom cut-float is operated in like manner.

The spacing of each float behind the preceding one depends upon the rapidity of the surface drying of the concrete and varies from 60 ft. to 200 ft. intervals. The steel cut-float is not used until the pavement is firm enough to walk upon without indentation.

The most efficient way to operate the float is to move it ahead the full length of the float upon completing the first cut, and upon completing the second cut, move back to

where the center of the float laps the joint between the first two passes. Upon completion of a lap cut, the procedure is repeated continuously ahead.

The essential features of efficient delayed finish are:

1. The floats should be continuously in adjustment; that is, the cutting edge must be true, and quick adjustments are provided for this purpose.
2. The operators must properly use the floats to cut before troweling the surface.
3. The interval between floats must be such that as much subsidence as possible is obtained, and the surface is yet workable enough not to throw an unnecessary load on any one float.

A light watering, if necessary, may be used along with floating, to cut down the drag on the float if it gets too far behind for good operation. Surface hardness tests have shown that a small amount of water will not damage the surface, but as a matter of good practice, it must not be over-done.

Asphalt Concrete

Construction Methods

A decided improvement has been made in the average riding qualities of asphalt concrete during the past season, which is largely due to the improved equipment used to spread and to roll the mixtures, to the use of better methods in straightedging, and to better-trained personnel. Contractors have generally discarded obsolete equipment and provided the latest improvements when replacements were made. The marking straightedge, similar to that described in the February, 1937, issue of California Highway and Public Works, has been generally used throughout 1936.

The large amount of asphalt concrete pavement laid during 1935 has given our construction personnel a wider training in laying this type of pavement, and that training has been reflected in the past season's work. It has been found necessary to increase asphalt contents to compensate for the inert asphaltenes which are disclosed



Bump-Rolling Asphaltic Concrete Pavement

in the petroleum ether solubility test. These increases in asphalt are contributing to the workability of mixtures and likewise aiding in obtaining smoother riding pavements. The increased asphalt should insure a longer service life in this type of pavement.

Construction Records

The maximum daily output of asphalt concrete was obtained in Solano County from 3.7 miles north of Fairfield to 0.6 mile south of Vacaville, 694 tons being produced per 8-hour day. The average daily output for the State was 447 tons during 1936, compared to 520.5 tons in 1935, the reason for the decreased average tonnage being the increased number of small projects.

The highest average stability of surface mixture was 3,550 lb., obtained in Los Angeles County, on San Fernando Road through Newhall. The average stability for the state was 2,650 lb., compared to 2,908 lb. in 1935.

The densest surface mixture was placed in Los Angeles County from Fenwick Street to Scoville Avenue in Sunland with a relative specific gravity of 97.7 per cent. The state average was 94.3 per cent, compared to 95 per cent in 1935.

The smoothest asphalt surface was placed in Los Angeles County on San Fernando Road through Newhall, with 11.4 in. per mile.

The average smoothness for the State was 14.7 in. as compared to 21.1 in. per mile in 1935.

On surface course, our rolling procedure is to break down with three-wheel rollers and follow with a cross roll at right angles to the pavement center line, when the temperature of the mixture ranges between 125° and 135°. This cross roll is performed by driving the roller completely over the side form on both sides of the pavement, if possible, doing all of the turning on the shoulder area, and lapping one-half the wheel width on each successive trip. The entire area of surface is covered in this manner.

Following the first cross roll, the pavement is checked with a 5-ft. marking straightedge, and as soon as the temperature of the mix drops to approximately 100° F., a second tandem roller performs the so-called bump rolling. In this operation, the street inspector guides the roller over the transverse wave, centering the large roll directly on the peak of the wave, and transverse rolling is continued until the wave has been flattened to a degree in which a 5-ft. straightedge when laid on the surface parallel to center line, will show no perceptible variation from the pavement surface.

The new type of three-axle roller has been used to considerable extent during the past few years, and we permit the elimination of the necessity of the fourth roller when such becomes necessary if one of the rollers is of the three-axle type. These rollers, if properly constructed, accomplish the same result as the first cross roll. It has been necessary to require reinforcing the frame on a great many of these rollers, in order to make them effective.

While laying pavement in summer temperatures, it becomes necessary to artificially chill the surface with water in order to reach the desired temperatures at which to roll.

Bituminous Treated Surfaces

The mileage of road-mix surfacing again predominated in 1936, there being constructed some 126 miles of this type, as compared to 82 miles of plant-mix.

The record for surface smoothness of plant-mix, 14.2 in. per mile, was made in San Bernardino County, from Verdemon to 0.8 mile west. The average roughness index for the state during 1936 was 33.5 in. per mile, compared to 36 in. in 1935.

For road-mix type, the smoothest surface was obtained in Inyo County between Big Pine and Keough Hot Springs, with 12.1 in. per mile. The average roughness index for the state during 1936 was 30 in. per mile, compared to 37 in. in 1935.

Ridging qualities are built into road and plant-mixed projects by placing mixtures in light lifts and obtaining full compaction before spreading each subsequent lift, which is readily done, especially on road-mix surfaces. Any desired amount of material can be cut from the mixed windrow and laid out in each operation.

Our specification for plant-mix requires blading out an inch depth of the uncompressed mixture, and feeding this back to take up the irregularities as they develop during compaction. Contractors have found that it is a more economical procedure to lay the surfacing in two courses. This method allows them to obtain full compaction with less equipment and eliminates the necessity of working with cold material.

Good blading practice on oil-surfaced roads which are constructed on firm bases, results in riding qualities which are as pleasing to the motorist as are some of the higher types of pavement.

Roadside Development Report Issued by Highway Research Board

A report on roadside development has been published by the Highway Research Board of the National Research Council covering the work accomplished during 1936 by the Joint Committee on Roadside Development of the Board and the American Association of State Highway Officials.

Intended for use as a reference by those working in the field of roadside improvement, the Report is also an important document for garden clubs and civic organizations interested in furthering the efforts of the highway and landscape engineer.

Among the subjects considered are the history and purposes of roadside development work, surveys and plans for a comprehensive roadside program, control of erosion, grading operations, drainage, types and methods of planting, rural and urban zoning, public relations and education. Miscellaneous discussions concern such items as mowing operations, snow drifting, safety features, pole lines, mail boxes, and newspaper containers, while current practice in the various States with regard to shoulders, ditches, and back slopes is summarized from the results of questionnaires. A bibliography of literature on roadside development is included.

The report contains 96 pages. It can be obtained from the highway Research Board, Washington, D. C., for 25 cts.



445,000 MILES OF STATE HIGHWAY.—On Jan. 1, 1937 the total mileage of state highways was almost 445,000 miles, an increase of 15,500 miles during the past year. Over 345,000 miles are surfaced.



3,993 BRIDGES CONSTRUCTED IN 1936.—During 1936 state highway departments constructed 3,993 bridges of over 20 ft. span, and eliminated 858 railroad grade crossings.

Road Surface Resistance to Skidding

The Department of Scientific and Industrial Research, 16 Old Queen St., Westminster S.W. 1, London, England, jointly with the British Ministry of Transport, has issued a second paper in the series of reports on the study of the road surface resistance to the skidding of motor vehicles, which is being carried out under the Road Research Board at the Department's Road Research Laboratory at Harmondsworth. The problem can, of course, be investigated experimentally by skidding full size vehicles upon a specially prepared ground. The high cost involved and the risk of accidents have naturally caused attention to be directed to the possibility of using small scale models. Before models can be designed or the investigations placed on a practical basis it is necessary to understand more fully the factors affecting the measurement of skidding phenomena so that the laws governing comparisons between models and full scale vehicles can be produced. In the present report further data from full scale experiments are analyzed and general conclusions are drawn from which the laws relating to models can be derived. The following is a summary of the report:*

The report points out that the friction coefficient between a pneumatic-tired wheel and a road surface may be measured at right angles to, or in the direction of travel of the plane of the wheel, or in any direction between them. In practice, however, the two limiting values are of particular importance, as they give an indication of the resistance to sideway skidding ("sideslipping") and to straight-ahead skidding (such as may occur when a vehicle is braked). Experimental investigation has, therefore, been directed particularly towards the measurement of these two values, and has resulted in practice in the following two methods being employed:

The measurement of the sideway force, defined as the force acting at right angles to the plane of the wheel, while it is being dragged forward, rotating, with its plane of rotation vertical and at some angle to the direction of motion. The load on the wheel is also measured, and the two are combined to give the ratio sideway force to load which has been termed the "sideway force coefficient."

The measurement of the braking force acting in the plane of the wheel, while it is being dragged forward rotating, with its vertical plane in the direction of motion, but slipping by a certain amount (zero slip represents free rotation, and 100 per cent slip, complete locking of the wheel). Again, the wheel load is simultaneously measured, and the ratio braking force to load, which has been termed the "braking force coefficient," obtained.

An apparatus consisting of a special motor cycle and sidecar, the wheel of which can be inclined at an angle to the direction of travel, has been used to measure the sideway force coefficient and a number of the results of the measurements with it on different road surfaces in widely varying weather conditions have been published (Technical Paper No. 1.). The general nature of the results obtained are summarized in the present report. Braking force measurements derived from straight ahead skidding

have now been made with a specially designed single wheel trailer towed behind a lorry. From the results obtained a number of the laws governing the use of models in slip experiments have been deduced and the conditions which would have to be applied to the speed of the model and the type of road surface are stated. Experiments have been made that show that these latter conditions, though exacting are not impossible of realization. Provided they are fulfilled it would be possible to take a model of linear scale, say 1/16th of the original, project it so as to skid upon a prepared surface and photograph it with a cinematograph camera from above. If the photographs are then projected on a screen so that the linear dimension becomes that of the full size vehicle and if the speed of projection were then a fourth of the speed of taking, the picture would represent in time and in linear dimensions the path which the full size vehicle would have taken when skidding on a similar road surface. From this picture could be obtained, the report states, all necessary data regarding the path of the skidding vehicle though practical difficulties might be considerable.

A final section of the report deals with the estimation of stopping distances derived from the speed and friction coefficient curves obtained with the motor cycle and sidecar combination. It is very difficult, the report states, to classify a road surface as "dangerous" or "safe" by numerical values of the sideway or braking force coefficient. Generally speaking, a surface giving a sideway force coefficient of 0.5 or more at 30 m.p.h. may be regarded as safe, whilst a value of 0.2 or less indicates a surface which may give rise to dangerous conditions, and therefore needs attention. Between these values the "safety" indicated depends upon the situation and traffic conditions, having due regard also to the characteristics of the surface at the lower speeds. In order to throw more light on this somewhat difficult matter, a method of deriving distances in which vehicles can stop on a surface having any given speed/friction coefficient characteristic, has been developed. It is suggested, that classification by stopping distance in the manner described, may be more useful than by coefficients obtained at 30 m.p.h. alone. Moreover, when carrying out skidding experiments using models, two factors which are very easy to measure, are the stopping distance and initial speed of the model.

The stopping distances worked out in the report from measurements upon a "bad" road for the motor cycle and sidecar combination having smooth tires show that with an original speed of 20 miles the stopping distance is 71 ft. and for a speed of 30 miles an hour about 300 ft. Examination of the curves for stopping distance and speed bring out the point that there is far more difference between the stopping distances for medium and bad roads from the skidding point of view at speeds above 20 miles an hour than the friction coefficient speed curves alone would indicate. Moreover, as regards stopping distance, while there is little to choose between the curves for medium and good roads for speeds up to 30 miles an hour it is clear there would be a considerable difference at higher speeds. The results given indicate very clearly that the speed of traffic over a particular road must be taken into account in deciding what a safe value of coefficient for that road should be and secondly that high coefficients at low speed are not so important as maintaining a reasonably good coefficient at higher speeds.

*Rand Research Technical Paper No. 2, Published H. M. Stationery Office, London, England, at 24 cents.

OBSERVATIONS BY THE WAY

By A. PUDDLE JUMPER

¶ Did you ever read such an asinine argument as was put forth in the Washington (D.C.) Post for the morning of Dec. 1? It ran something like this:

—Sure, Mr. Congress, you should cut the federal aid allotments. All, of course, except where I live. You should give Washington some. Cut everybody else but me.—

How many cities in the country know that Washington is already getting a break in gas tax collections that they are not getting? Do they know that Washington keeps all the gas taxes collected in the city? Do they know that Washington is now getting ready to beg Congress for a share of federal aid funds? If Washington can get that so should all other cities in the country.

• •

¶ What should really happen is, that Virginia and Maryland should erect Ports of Entry and charge all D.C. cars so many cents per gallon fee for the gas in their tanks. Washington has a lower gas tax than Maryland or Virginia purposely to influence buying motor fuel in Washington so they can get the tax, regardless of how much driving Washingtonians do on Maryland and Virginia highways.

• •

¶ Dr. Arthur Casagrande, Professor of Civil Engineering, Harvard University, at the recent Highway Research Board meeting: "FOCUS PLEASE." "FASTER PLEASE." "FOCUS PLEASE," but the movie went on as started. Tough luck, Doc.

• •

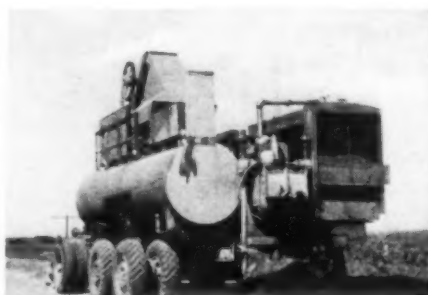
¶ Heard at Highway Research Board gathering:

G.M. to an old friend: "Hello, C.T. Well, I see you're sittin' around, spreadin' out."

Mebbe G.M. wasn't so far wrong, either.

• •

¶ A. P. J. desires to correct an impression that was left by a remark in the November issue on page 48. What was stated there is true. I was told exactly what appears. The machine had no manufacturer's name on it anywhere; and I looked for it.



This machine, pictured herewith, was made by the Iowa Mfg. Co. of Cedar Rapids, Ia. They have made many like it and are still making them. In fact, this company claims they made the first one of these machines ever made.

This error brings to the front again, what was editorialized in a previous issue of ROADS AND STREETS, viz., that manufacturers should have large name plates prominently mounted on their equipment. A. P. J. apologizes for the erroneous impression. He tries to get his facts correct at all times. Being human, he can err.

• •

¶ Highways "like you read about" may be driven in Missouri. There is a wonderful stretch on U.S. 40 between St. Louis and Kansas City. Streamlined cross-section, lip curb and positive drainage control, erosion control, easy curves, smooth surfacing, super-elevation where needed, easy grades and all the refinements that make an A-1, first class highway.

• •

¶ That idea of marking curves for maximum safe speeds that I saw on U.S. 40 between St. Louis and Kansas City, is excellent. A little square sign with reflectorized buttons forming the speed number, like 35, 40, or 50, gives the night driver a very definite idea of how fast he can travel on the curve ahead which is, at the time, not visible in his headlight beam.

• •

¶ A bomb dropped into the Roadside Development Committee meeting of the A.A.S.H.O. when A.P.J. suggested that ideas to capitalize idle driving time be crystallized in the form of ornamental signs hung from poles along the right of way lines. On these signs A.P.J. suggested that his-

torical incidents of the area could be placed such that they could be read while the car was travelling 50 miles an hour. A.P.J. got his neck stepped on plenty but he still wonders why the idea is so bad so long as the right of way edges are lined with telephone and telegraph poles and no mention made of eliminating them.

• •

¶ Those grade crossing signs one sees in Canada prior to crossing a railroad track are a credit. The lights of a car can strike them easily and the warning is sure. They are placed low on the shoulder of the road a few hundred feet before the track is crossed.

• •

¶ I suggest the commissioners of Schenectady visit New York to see how to expedite traffic. Try getting east and west through Schenectady at the close of business hours. It's about as bad as battling traffic in Los Angeles, Calif.

• •

¶ Why doesn't New York State remove some of those myriad signs along the road in that beautiful Finger Lakes Region that skirts the north of those lakes? In some of those towns and villages they're an abomination.

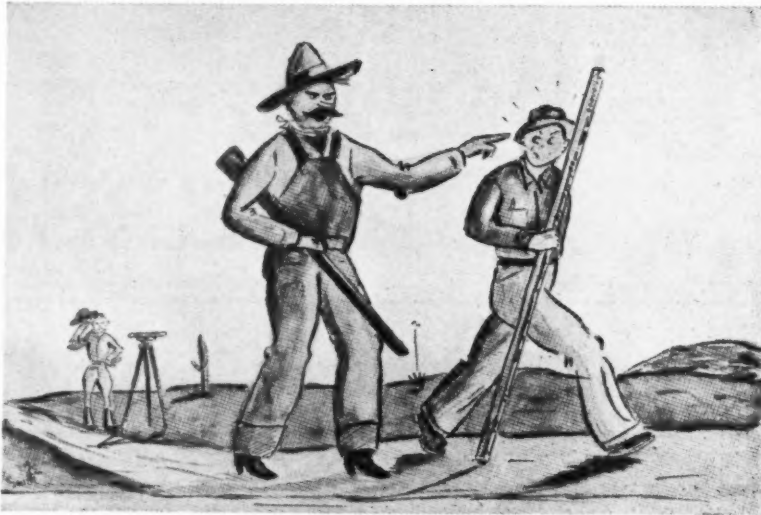
• •

¶ One thing seriously needed in New England, is a highway that misses towns and loops around New England. Travel there now is too slow. A superhighway has been sug-



Courtesy Arizona Highways

Who is it humps o'er cluttered desk, oft times on verge of tears from solving hieroglyphics, so-called notes of engineers? Who nearly always takes the rap from field-chief to the last man? The sweating, blinking goof who likes to call himself a DRAFTSMAN.



Courtesy Arizona Highways
The Rodman Takes a Wife

gested. We hope the federal government supports the idea.

Overheard at the last convention of the A.A.S.H.O.: "Working for a state highway department now-a-days is like playing an harmonica; to get along you gotta suck and blow."

May we suggest to New Jersey that she lower most of their directional sign boards. They are so high that driving lights of the automobile do not strike them at night. Those reflectorized and lighted signs are praiseworthy.

At conventions, whether state highway officials, contractors, or even police chiefs—boys will be boys.

Cities and towns are still the hardest places for the motorist to find his way. Is it asking too much to have state and federal route markers in every block through them? On an 800-mile trip through eastern and central Illinois we were not once in doubt as to our route outside municipalities, but experienced minor difficulties inside some of them. The State has done a fine job of marking. A little more, and it would be close to perfect.

The other day at Pittsburgh I had lunch with two prominent engineers in highway work. I mentioned the fact that Mr. Runner and I were preparing a comprehensive "Glossary of Engineering Terminology" and asked them to submit a list of words and their definitions as used in their branch of road building. The word "Stabilization" came up; or what would be the definition of "Stabilize" as referring to road work. Strange

as it seems, these two men who talk about stabilization almost daily did not have the same conception of the term nor did my conception approach theirs. Yet we highway engineers talk glibly about highway stabilization. As a matter of fact we don't know what we're talking about.

What is your conception of the word as used in street and highway engineering? Send it to me.

That's not the only thing we discuss glibly, yet about which we have no common understanding. How about the word "Maintenance"? What is it and what does it include and exclude? Send me your answer.

If it costs \$5,000 a mile average, to put in a mile of highway lighting equipment and \$500 a mile per year to maintain and operate the lights, how many miles should we build each year?

Highway safety and highway lighting are closely related. Should all danger points be lighted? It is claimed that the extra gasoline consumed by extra night driving would provide a tax income sufficient to justify lighting of danger points, over a period of years. What do you think?

The following is, as near as I can recall, C. B. McCullough's definition of a friend: "A friend is a man who knows *all* about you and whom you know *all* about and yet he still likes you." Doc Mac is Assistant State Highway Engineer of Oregon. Did I get this right, Doc?

A word of compliment to the engineer who designed those hill-top paving surfaces three lanes wide on a normal two lane road. I noticed some in New York State and in Massachusetts, too, I believe.

Why doesn't Baltimore do something to expedite traffic on that short stretch of street south of the Montgomery Ward & Co. retail store on U.S. 1? Those big cargo trucks all but close off the narrow street.

And speaking of signs, some of our local booster clubs seem to be falling down on their opportunities. "Twenty-six Miles to Skeetsville" is a good advertisement, but Skeetsville doesn't bother to put up the sign, although Flytown, ten miles farther on, tells us a half dozen times just how close we are to it.

What I can't understand is why state and county highway engineers neglect to make slick road surfaces smooth when materials, methods, men and money are available at their command. In the face of the nation-wide safety drives, our highway administrators apparently prefer to "play ostrich" and pay no attention to those road surfaces that get slick, especially when they become wet. There's no alibi an administrator or official can present that will satisfyingly explain a slippery road surface in this day and age. Were I to start naming states and names, the list would get pretty long. But if many of these "Slippery When Wet" road surfaces are not made skidproof soon, I'll start turning the lights on those responsible.

When does elevation equal super-elevation? Answer: When you're riding on a train.



Yes! We Have No Apples Today



ROAD BUILDERS'

DECEMBER, 1937

AMERICAN ROAD BUILDERS'

TOMORROW'S IDEAS AT

Down the Road

By CHARLES M. UPHAM

Engineer-Director,
American Road Builders' Association, Washington, D. C.

GOOD ROADS AID RURAL MEDICINE

A few months ago in a California hospital, a little girl lay seriously ill of pneumonia. From a distant state, an airplane rushed an artificial lung to her bedside. This combination of modern science and modern speed saved the life of this child.

At the same time, in a Kansas farmhouse, an 18-month-old boy pulled a boiling kettle of preserves from the kitchen stove. Its scalding contents poured over his head. A driving storm the preceding night had blown down the telephone wires, so the baby's father started for town in his car. He made slow progress over the washed-out road and on the return trip with the doctor the car bogged down in the mud. They waited 15 minutes for a lift from a passing car.

When they finally reached the farmhouse, they found that the makeshift first aid administered by the farmer's wife had been inadequate for so long a period. If the doctor had arrived 15 minutes sooner his skill would have saved the child. The delay had proved fatal.

The first of these stories made headlines throughout the nation. People read and marvelled at the advances made in medicine and aviation. The second story was of merely local interest. Its readers sympathized with the farmer and his wife, but failed to realize that blame for the tragedy rested on the unimproved condition of the road.

New inventions and scientific developments of all kinds are indeed cause for public pride, but the public must find

shame in the fact that the nation's roads are, in many places, relics of a far less progressive day. The times when medicine must appeal to aviation for aid are very rare, but the times when a road may make all the difference between life and death are occurring constantly.

The city dweller knows little of this. In case of sickness, he need only turn to his telephone to find a physician within a few blocks, possibly in his own apartment building. Illness in the country presents a much more serious problem. There the question of transportation looms very large. A trip which, over a good highway, would take 10 or 15 minutes, will often, over a dirt road in poor repair, require an hour or more and, in some cases, become an impossible undertaking.

"Lose a minute and save a life" has long proved an excellent maxim at railroad crossings. However, to a person taken suddenly ill, with a long stretch of bad road between him and medical aid, to "lose a minute" may well mean to "lose a life."

Thomas S. O'Connell, one of the directors and best-liked members of the American Road Builders Association, died Nov. 4. Mr. O'Connell had been Arizona's state engineer since 1931. He became connected with the state highway department in 1913. He was born in San Francisco, Calif., July 14, 1888.

DISTINGUISHED SPEAKER WILL ADDRESS 35TH ANNUAL GET-TOGETHER

Four hundred exhibits of the very newest and best in road-building machinery and materials will occupy the spotlight at the 1938 Road Show and Convention in Cleveland, during the week of January 17. These displays will consume every foot of available floor space in the Cleveland public auditorium, one of the few halls in the country large enough to house an exposition of such magnitude.

One of the nation's most distinguished speakers on a subject closely related to highway affairs will address the feature Convention get-together. A gala group of some of the nation's more popular entertainers will cavort in a pleasing manner to polish off a week of "five-star" innovations.

A spicy spot on the Convention calendar will be the second annual gathering of the "Old Timers"—a high-spirited reunion where those very privileged persons will have a grand opportunity to swap yarns that will no doubt begin with "back in the days when . . ." And, believe us, there will be some interesting yarns swapped.

Scores of delegates from Canada, Mexico, South America and Europe will swell the 1938 Road Show-Convention attendance with the largest Pan-American and European representation in the 35-year history of the world's greatest highway exposition.

With so wide a selection of made-to-measure interest, the Road Show-Convention visitor can't go wrong when it comes to choosing the Convention sessions he is going to attend. Every meeting will be brimming over with tomorrow's ideas.

And so we will be seeing you at Cleveland when the Convention and Road Show opens on Jan. 17.

REVIEW



ASSOCIATION—WASHINGTON

DECEMBER, 1937

A. R. B. A. '38 CONVENTION

FREE ROAD SHOW-CONVENTION TRIP, OTHER PRIZES OFFERED BY A. R. B. A.

The A. R. B. A. is offering 155 prizes to state highway department employees, excepting chief engineers, commissioners and department heads, who submit winning articles on the following subjects:

A description of some recent development in methods, materials or equipment that is of economic value to the construction and maintenance of highways.

A description of some invention or development in methods, materials or equipment that is necessary in order to bring about further economic value to the construction and maintenance of highways.

A plan for a course of action to obtain the necessary laws to conserve highway revenues for highway purposes and to prevent diversion of the gasoline tax and other motor-vehicle revenues.

A description of a plan for an ideal highway that would safely and sufficiently serve modern traffic, both passenger and freight.

A description of a plan for the elimination of traffic congestion in metropolitan areas.

A description of a plan for a system of national highways and its co-ordination with the present state highway systems. This plan must be economically justified.

A description of a development in the design and control of soil mixtures to attain maximum stability. (Discussion of any of the various methods of stabilizing soils and fills, pavement bases, or road surfaces would be pertinent to this topic.)

A description of a development in equipment for the construction of stabil-

ized roads.

A discussion of the place of the stabilized road in our low-cost or farm-to-market highway program.

The first prize in this contest is an all-expense trip to the 1938 Road Show-Convention. There are two second prizes of \$75 each toward the expenses of a trip to the Road Show-Convention and there are two third prizes of \$25 each toward the expenses of such a trip. There are 50 fourth prizes, each being a two-year membership in the American Road Builders' Association and there are 100 fifth prizes, each being a one-year membership in the association.

Contest results will be announced not later than January 7, 1938, and arrangements will be made at that time for the presentation of the prizes. Judges of the contest are the Honorable Wilburn Cartwright, United States Congressman from Oklahoma; H. K. Bishop, chief, division of construction, United States Bureau of Public Roads; H. F. Clemmer, engineer of materials and tests, District of Columbia; Roy D. Crum, director, Highway Research Board, Washington, D. C.; Dr. H. C. Dickinson, chief, division of heat and power, United States Bureau of Standards, and H. C. Whitehurst, director of highways, District of Columbia.

This contest affords someone the excellent opportunity of visiting the Road Show exhibits and attending the Convention sessions without cost. The contest has awakened more than a considerable amount of interest and it is expected that there will be several hundred entries mailed to the A. R. B. A. offices in Washington before midnight, Dec. 22.

SPECIAL PLANES TO BRING ROAD BUILDERS TO ANNUAL CONVENTION AT CLEVELAND

Preparing for the influx of Cleveland-bound traffic incident to the 1938 Road Show and Convention of the American Road Builders' Association from January 17 to 21, officials of United Air Lines have announced plans to fly special plane loads of road-building leaders to Cleveland, from points east and west, on its midcontinent coast-to-coast airway.

De Luxe Mainliner sleepers, acclaimed the world's most luxurious high-speed transport, will bring the convention men to Cleveland from the Pacific Coast with only three intermediate stops. Delegates who leave Los Angeles and San Francisco at the dinner hour will reach Cleveland the following morning. Passengers on the convention special from the West Coast will enjoy a hot, full-course dinner before retiring. They will have a full night's sleep and have breakfast during the last leg of the flight, between Chicago and Cleveland.

So great is the demand for air travel space in connection with the convention, it is expected that special plane loads of conventioners will originate in New York, Chicago and Philadelphia, as well as points west. United also announced that it will have a booth at the convention hall to handle information and reservations for those who will be returning from the conclave by air.

VISIBILITY AND NIGHT TRAFFIC ACCIDENTS

By L. A. S. WOOD

Chief Lighting Engineer, Westinghouse Electric and Manufacturing Co.,
Cleveland, Ohio

PUBLIC authorities and the public in general apparently accept the steadily increasing annual automobile fatality rate as the inevitable result of increased traffic volume and greater speed.

During the past 20 years car registrations have increased 600 per cent, the average mileage per car 125 per cent, and the average speed 100 per cent.

Twenty years ago visibility distance with automobile headlights on light dry roads was 200 to 250 ft. and almost nil on dark or wet roads. Today, with more cars and greater speed, automobile headlight visibility remains the same.

Naturally, the illuminating engineer approaches the problem from a different angle from that of the average safety engineer. The illuminating engineer wants to know the visibility conditions under which traffic accidents and fatalities occur. He differentiates the fatality and accident statistics between daylight and darkness and discloses a startling and hitherto almost unseen picture.

Over a period of years the trend of traffic fatalities follows closely motor car annual registrations. Public authorities appear satisfied with the effectiveness of their safety programs. When, however, fatalities in daylight and darkness are studied it will be noted that, since 1929 when safety measures and safety programs were first intensively promoted, daylight fatalities have steadily decreased while night fatalities have risen rapidly. This experience is recorded in spite of increased traffic and speed. Twenty years ago night fatalities were but 30 per cent of total; today, they constitute more than 60 per cent.

Lack of Night Visibility Is Cause

The sharp upward trend of night fatalities is significant of night time conditions beyond the control of the driver. Otherwise the safety measures, so effective in reducing the downward trend of daytime fatalities, would be equally effective at night. There appears to be an overall factor, absent in daylight, which influences the night fatality rate. Illuminating engineers and others who have studied the problem, believe that this factor, hitherto largely overlooked by public authorities, is *lack of visibility*.

Few people in fields closely related to the problem of public safety, even in fields dealing directly with the problems of traffic safety have realized the vital relationship of darkness with death. Few people have realized that traffic hazards remain substantially unchanged throughout the 24 hours, except that darkness comes down to confuse the driver and pedestrian.

Fatality Records

Last year, 60 per cent of the motor vehicle deaths occurred during hours of darkness, a period in which traffic is only 20 per cent of the total volume.

The greatest number of fatalities occur during the so-called "rush hours" between 5:00 p.m. and 8:00 p.m., but during these hours in winter, when it is dark, statistics show that twice the number of persons are killed than in the corresponding summer months, when it is light. R. E. Simpson, an authority on traffic accidents, recently made a special survey of 47 American cities for the National Bureau of Casualty and Surety Underwriters and found that the most dangerous streets are the main traffic thoroughfares at night, accounting for two-thirds of the total fatalities. These thoroughfares represent but 10 per cent of the total street mileage but account for more than 46 per cent of the night and 30 per cent of the day traffic fatalities. He found that in these cities, seven out of ten pedestrians were killed at night. He also found that 73 per cent of the pedestrians killed (both day and night) were involved in accidents on main thoroughfares and that 77 per cent of these happened at night.

Detroit's experience is extremely significant. The city, like many other American cities during the depression curtailed its street lighting service in the mistaken idea that money could be saved. It proved anything but an economic measure.

In 1931, Detroit had what was then considered a good street lighting system, and the day and night fatality experience was practically the same—119 deaths in daytime and 124 at night, for ten months starting January 1. In the following year, street lighting was reduced to 65 per cent of 1931 level and to offset this reduction, an intensive safety campaign was organized. In the corresponding ten months of 1932, the safety campaign reduced the daytime fatalities from 119 to 75 but the curtailed street lighting increased the night fatalities from 124 to 151.

Because of the alarming increase in night fatalities evidently caused by curtailed street lighting, the service was increased in 1933 to 85 per cent of the 1931 level, but there was no special safety campaign. In the ten months of 1933, with increased street lighting, the night fatalities dropped from 151 to 138, but without the safety campaign, the day fatalities went up from 75 to 90.

Mr. Simpson has stated that, "Every survey of streets where fixed lighting has been installed in accordance with illuminating engineering specifications, has shown that the night accident rate decreases as the grade of street lighting increases. The sum total of all investigations supplies unmistakable evidence that properly designed fixed lighting can and does provide adequate visibility and that visibility has a far more important bearing on the night accident rate than is credited by the public in general or by public authorities in particular."

Adequate Lighting Reduces Accidents

The facts are clear, simple and beyond all question. The conclusion they establish is not so astonishing as the

apparent failure of public authorities to meet it seriously or at least seriously enough to do something about it. Safety campaigns and all the other safety measures, to be effective *both day and night*, must be coordinated with the overall factor of darkness. They should be accompanied by measures which will improve night visibility such as modern street lighting and adequate systems of fixed lights on the highways.

Night Visibility

Objects are seen at night by either of two entirely different processes. The object may be illuminated with sufficient brightness that every detail of the object is observed, or the object may be seen as an outline contrasting with the pavement beyond which, under a system of fixed lights, is generally brighter than the object observed.

Discernment by surface detail and discernment by silhouette are, to a considerable degree, mutually opposed. More light on the object provides better discernment by surface detail and poorer discernment by silhouette because the brighter the object, the less it contrasts with the background. Conversely, the more light on the background and less on the object provides better discernment by silhouette and poorer discernment by surface detail.

In business districts and so-called whiteway areas where super-illumination is provided for its advertising value, objects are clearly discerned by surface detail, but in thoroughfares, residential districts and on the highways, we must depend on discernment by silhouette for adequate night visibility.

Night Visibility by Headlights

On our highways, where at present there is scant highway lighting, objects on or immediately adjacent to the road are seen at night in the illumination of automobile headlamps by the light reflected from the objects toward the automobile driver. They are visible in proportion as light reflection from their surfaces is good or they may be visible because they are naturally darker or lighter than the more distant pavement as lighted by the headlamp beams. When seen against the pavement illuminated by approaching headlamps, they appear as silhouettes.

There are certain limitations in automobile headlighting which must be recognized before the advantages of adequate street and highway lighting can be fully appreciated. When the pavement is light in color and the road surface is dry, headlamps provide safe and pleasant driving conditions at normal speeds, except for the glare of approaching headlamps.

When the pavement is wet, instead of diffusely reflecting the light (like blotting paper), it reflects light specularly (like a mirror) with the result that headlamp beams are reflected in a direction away from the driver's eye, leaving the pavement substantially black. In this case, objects are seen only by the light reflected from them toward the driver, and since such objects are predominantly dark in color, their visibility is low.

On dark dry pavements also, predominantly dark objects are seen only by the light which they reflect back to the driver's eye.

Many improvements have and are still being made in automobile headlamps, but there is one major limitation which cannot be overcome, legislative limitation of beam

candle power. Furthermore, long continued and intelligent efforts have conclusively established the impracticability under actual driving conditions, of controlling headlight glare to a point where it will produce no material discomfort and no serious reduction in visibility.

Headlamps are needed on automobiles, that we can see at all on unlighted streets and highways, but as a satisfactory solution to night driving under all varying road surfaces and weather conditions, they fall far short of the ideal.

Polarized Light

Recently there has been much discussion concerning the merits of polarized light as a remedy for the night visibility problem. Extravagant claims have been made for it—some valid, others erroneous and ill considered. Polarized light can undoubtedly have a favorable influence on one factor contributing to the dangers of night driving—glare. Polarized light can greatly reduce the glare of headlights; so would less powerful headlights. But not only does polarized light fail to increase existing illumination—it actually reduces, by about 40 per cent, the effectiveness of both headlights and street lighting. It should be recognized that polarized light does not even potentially embody a solution to the night visibility problem. Even if its application were practical, which is questionable, its physical limitations are many.

Driver Visibility

The burden of avoiding traffic accidents rests mainly with the automobile driver. When an accident is imminent, the pedestrian is either too close to danger or too confused to help himself. Except in areas where super-illumination is provided and discernment by surface detail is possible, modern street and highway lighting practice gives maximum visibility to the driver.

It is now recognized that objects are seen more readily by contrast, either of color or brightness (silhouette) than by direct illumination (surface detail). From this it is evident that to provide maximum visibility, the road surface must be rendered bright so that objects may be seen by the motorist in silhouette.

In order that the pavement shall appear bright, it is important that much of the direct reflection of light from it shall be in the direction of the driver. An adequate and effective lighting system should produce this surface brightness under all changes in road surface conditions. The ideal is uniform surface brightness, although in practice, it is relatively unimportant.

The brightness of any surface containing an element of specularly is affected by the angle at which the light strikes the surface (angle of incidence) and the angle from which the surface is viewed (angle of reflection). Herein lies the reason why many motorists find it increasingly difficult, when driving up-to-date cars, to see clearly at night on urban streets and thoroughfares. The modern low built car seats the driver closer to the road surface than with cars of the older type and his eyes are thus located below the angle at which he can see surface brightness with many existing street lighting systems. This difficulty, however, is not experienced in downtown districts where discernment by surface detail is possible,

Pavement Brightness

It is a simple problem to design a lighting system which will produce uniform brightness on a light dry (diffuse) road because the light from lamps located adjacent to the roadway, on striking the road surface will be diffused in all directions, and the surface will appear bright when viewed from any or all directions.

Producing surface brightness for the driver on a dark or a wet road surface requires careful study and involves refinements in luminaire design and placement. Most roads possess an element of specularity, and a lighting system which is effective on a wet road surface should provide adequate visibility on a dry dark surface. In addition, it will produce effective visibility on a light dry road.

"Problems of spacing, mounting height and luminaire design are interwoven and mutually dependent. A large proportion of the light which is provided should be delivered on the roadway and this should be accomplished with the most uniform distribution of brightness and with the least possible glare. In order that the pavement shall appear bright to the motorist, it is important that the light sources be located well over the roadway."

These and other recommendations for effective night visibility have been prepared by the Street and Highway Lighting Committee of the Illuminating Engineering Society.

Modern Street Lighting Practice

Based on the requirements of the I. E. S. Code and a new street lighting technique, new types of street lighting equipment have been developed to meet the needs of modern street lighting practice. In the new luminaire, which is designed for a spacing-mounting height ratio of 5 to 1, the light source is completely shielded from the eye of the observer, thus mitigating glare. By the addition of a system of reflectors within the globe, the light flux is distributed at a grazing angle up-and-down the street to produce maximum surface brightness against which objects may be seen in silhouette. At the same time, the house fronts are screened from undesirable light. These luminaires are located on brackets over the roadway and suitable standards are available for their support.

Highway Lighting

In interurban highway lighting, at the relatively low levels of illumination economically possible, discernment by silhouette assumes even greater importance than in urban street lighting. The problem, therefore, is to provide maximum surface brightness.

The same rules apply as in urban thoroughfare lighting, although the public authority responsible for highway lighting and the methods of financing the service are different.

Visibility Distance

According to a recent report of the American Road Builders' Association, studies indicate that a visibility distance of 1,800 feet is requisite for safe use of the highways under modern traffic conditions. By day this objective may be attained by the elimination as far as possible of vertical and horizontal curvatures as well as natural and man-made obstacles. This will entail realigning and rebuilding many of our highways at heavy cost and will also increase the cost of new highways.

Such a protest of highway improvement is commendable, but it will only provide visibility for the 4,760 hours of daylight in the year. What about the other 4,000 hours of darkness? Would it not be better to light our highways adequately and make curves, obstructions and grades clearly visible at night? In the final analysis, economics will determine the best procedure.

Distribution of Traffic

The report of the A.R.B.A. further states that "there exists with good reason a decided disinclination on the part of the public against night driving. The eye strain induced by headlight glare, the nervous tension brought about by the repeated experience of driving past glaring headlights into possible unseen and unknown danger, the increasing public appreciation that night driving is more hazardous than day driving all tend toward greater concentration and congestion of day traffic than would be the case under safer night driving conditions."

"Graphs show a definite relationship between accidents and traffic flow with the accident curve consistently below the traffic flow curve during the day and just as consistently and abnormally above at night. If we had a standard of visibility at night approaching that during the day, it follows that the traffic flow and accident curves would bear the same relationship throughout the 24 hours."

Somewhat allied to the distribution of traffic is that of increasing the load factor on highways. This implies a community of interest involving the automotive, road building and oil industries. Day trucking has grown to such proportion that it constitutes a serious interference with the even and rapid flow of traffic. If more of this day trucking could be transferred to the lighter traffic of the dark hours, the day traffic would benefit. The keystone of increasing and redistributing the traffic load is adequate visibility at night and visibility at night is almost wholly a matter of adequate highway lighting.

Highway Lighting Saves Lives

There are relatively few systems of adequately lighted highways in the country where there are also records of day and night accidents and day and night traffic flow, before and after lights are installed, but the few examples we have substantiate the contention that adequate highway lighting reduces traffic accidents.

Recent investigation on the parkways in Westchester County, New York, covering a four year period, and also on the parkways of Long Island for a three year period is significant. The investigation covers a traffic exposure well over one billion vehicle miles. In Westchester County, with lights in full service, the ratio of day to night accident rates was 1 to 2.2; with the lighting reduced 40 per cent, the ratio was 1 to 3.7; and with all lighting turned off, 1 to 4.8. On Long Island, the day to night accident ratio was 1 to 1.4 with lights on and 1 to 2.6 with lights off.

Mr. Arnold H. Vey, Traffic Engineer, State of New Jersey, has made an analysis of the day and night accident experience on a well lighted, heavily traveled section of Route 25 and the less heavily traveled and unlighted section of Route 26. On Route 25, the accident rate per million vehicle miles was 3.10 by day and 2.61 by night, while on Route 26, the average for these sections was 2.50 by day and 8.00 by night. The accident record on Mount

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Vernon Memorial Highway shows 250 per cent increase in the night accident rate with the lights out of service as compared with the rate for an equal period with the lights in service.

The survey of the 1936 accident record of the 26.4 mile stretch of the Bayshore Highway in San Mateo County, California, is convincing. With the day traffic exposure of 75 per cent of the total, 39 per cent of the accidents occurred, while at night 25 per cent of the 24 hour traffic accounted for 69 per cent of the accidents. Of the fatalities, 18 per cent occurred by day and 82 per cent by night.

Thus we have a similar experience with highway lighting as with street lighting, indicating that lack of visibility at night is the predominating cause of the abnormal night traffic rate.

Luminaires and Lamps

The new sodium vapor lamp, owing to the monochromatic character of the light and its high efficiency, appears peculiarly adapted to highway lighting, and suitable luminaires designed for a spacing mounting height ratio of 8 to 1 have been developed. The high intensity mercury lamp also has its place in highway lighting for the illumination of grade crossings and dangerous intersections.

Highway luminaires for use with the new pre-focus bi-post Mazda lamp have also been developed. These are designed for a spacing mounting height ratio of 5 to 1, and these require closer spacing than the vapor units.

Highway Lighting Installations

According to the Code of Highway Lighting published by the Illuminating Engineering Society, the lamps should be mounted on one side of two lane highways. On three or more lanes, the lamps should be on opposite sides staggered. Double highways with traffic in opposite directions, separated by parkways or islands should be treated as two separate highways.

An overall system providing adequate illumination for dark wet road surfaces can be obtained with the 10,000 lumen sodium lamp in a luminaire designed for a spacing mounting height ratio of 8 to 1. This would involve approximately 22 units per mile. Such lamps should be mounted at a minimum of 30 ft. and supported on mast arms at least 5 ft. and preferably more out over the pavement. Owing to variations in length and location of existing power line poles, special poles should be used to support the luminaires.

Adequate illumination on two lane highways can also be provided by the 4,000 lumen bi-post Mazda lamp in a luminaire designed for a spacing mounting height ratio of 5 to 1. This would require almost double the number of units per mile than the sodium vapor installation.

Cost of Highway Lighting

It is estimated that an adequate sodium highway lighting system with special poles to support the luminaires, complete with the necessary transformer and control equipment will cost approximately \$4,000 to \$4,500 per mile. The resulting annual cost with fixed charges on the investment included on a 10 year amortization basis would be in the neighborhood of \$1,700 per mile per year.

With fixed charges on the investment excluded, the operation and maintenance cost of such a system is estimated at \$800 to \$900 per mile per year.

Financing Highway Lighting

Highway lighting will eventually extend for long distances, and is thus removed from the jurisdiction of the county or township. The financing of highway lighting service thus becomes a function of the state, to be financed out of gasoline taxation. This does not imply any necessity for additional gasoline taxation, but merely the application of excess gasoline tax funds, at present with doubtful legality diverted to other than highway purposes, to the purpose for which the tax was originally authorized.

Acknowledgment—The foregoing is a paper presented at the Kansas City, Mo., Safety Congress of the National Safety Council.



Special Safety Projects Reduce Accidents

Reports have been made on two special safety projects on the trunkline highway system of Michigan. One revealed a drop in the death rate on the 4-mile Farmington cut-off of US-16 from an average of ten a year to one within the last twelve months since it was restricted to one-way traffic. The other showed that accidents were reduced from nine to one since 10.3 miles of US 112 through the Irish Hills section of Lewanee County was made a special traffic control zone.

The Farmington cut-off was closed to west-bound traffic just a year ago after a death toll of 40 persons had been reached along the beltline since it was completed in 1932. There have been only two accidents along the Farmington cut-off within the last year—both at intersections. One person has been killed.

During the two months of May and June before US 112 was zoned through the Irish Hills section there were nine accidents and one death. During July and August there was only one accident and no deaths on this zoned highway. This achievement was made despite increased traffic occasioned by summer tourist travel.

The zoned area has a 45-mile-an-hour speed limit and traffic is prohibited from crossing yellow lines at 24 designated locations where sight distances are under 700 feet. State police and local officers have patrolled the area for violations with convictions calling for a \$100 fine or ten days in jail, or both.

Two-way traffic has again been operating on the Farmington cut-off within the last two weeks as initial construction activity got under way on a widening project at the west end of the village on US-16. The highway will be widened to 30 and 45 feet. When this widening is completed, it is planned to program a project for rebuilding the dangerous sections of the cut-off so that it may be made opened permanently for traffic both ways.

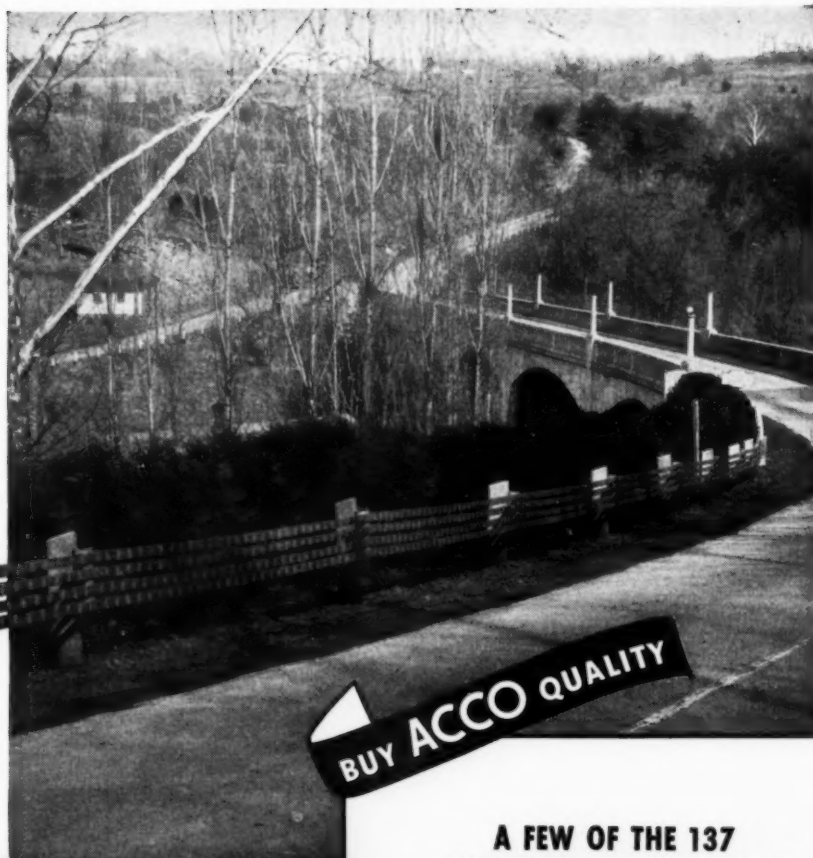


Diesel Powered Trucks in Foreign Countries

A total of 79,632 Diesel powered trucks and buses were registered in foreign countries in 1936, according to *Automotive World News*, a publication of the U. S. Bureau of Foreign and Domestic Commerce. This number represents a gain of 53 per cent over 1935 and is practically double the 37,816 Diesel units supposedly in use during 1934. Of the 1936 total, Germany had 33,900 (as compared with 15,000 during 1935), France had 15,300, and the United Kingdom 14,911.

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PAGE *Traffic* TAPE

Slope Drains and Sumps for Embankment Drainage

SEVERAL years ago the Ohio State Highway Department relocated U.S. 127 between Hamilton and New Miami. Included in that program was the construction of a mile and a half embankment approach to a new bridge over the Great Miami River.

Anticipating traffic requirements this embankment was made wide enough at that time for a 4-lane pavement but was provided with only a 20-ft. concrete pavement pending consolidation of the fill. Supplementing this pavement was a 10-ft. traffic-bound berm on each side.

In view of the unfinished aspect of the project at that time no particular provision was made for surface drainage. Water was merely shed by the crowned pavement to the berms and down the sides of the embankment. At points of concentrated flow transverse gullying soon developed and was held only partially in check by such maintenance expedients as the temporary wooden troughs shown.

Early in 1937 a contract was awarded by the state to Hinton and Smalley, Contractors, of Celina, O., for widening the existing concrete pavement with a concrete strip on each side to a completed width including integral curb and gutter of 41 ft.

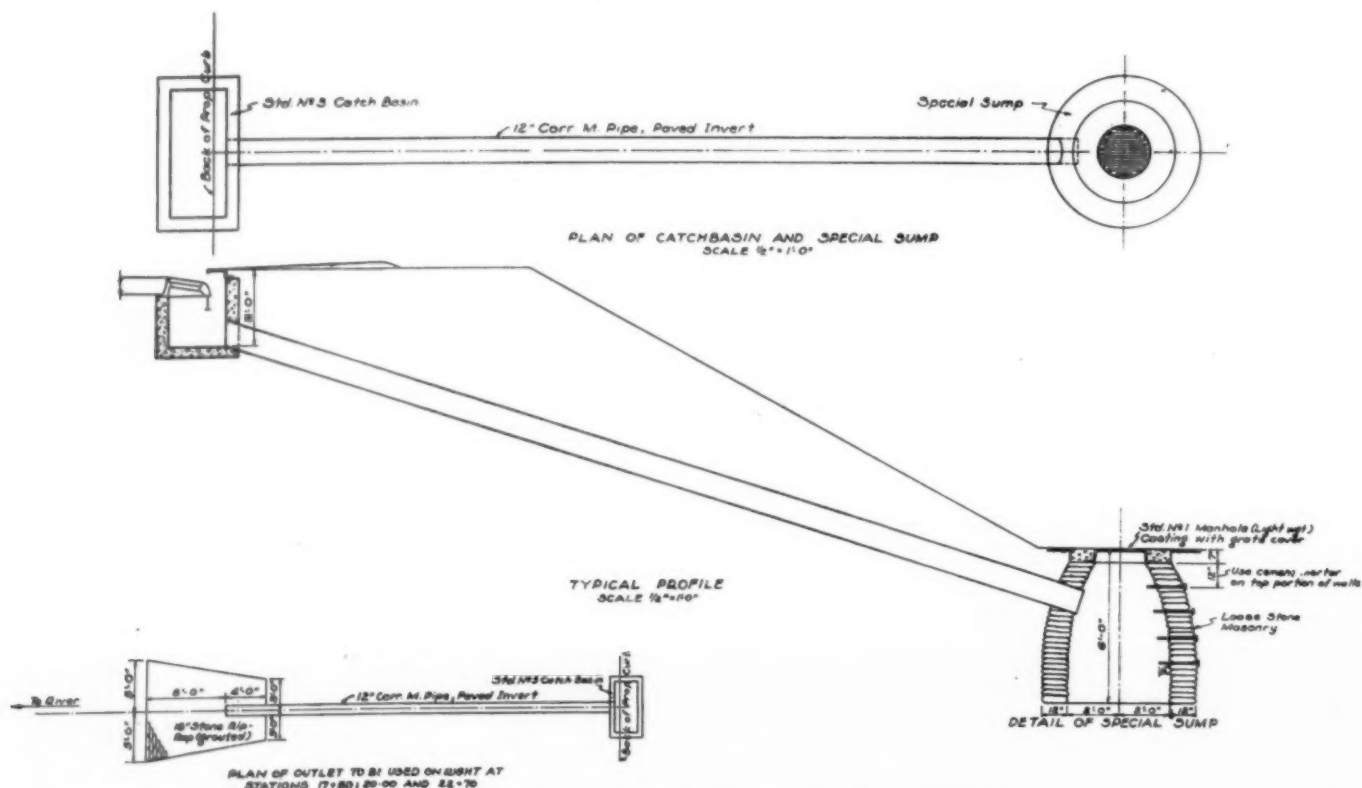
Plans for completing the roadway included provision for adequate and lasting surface drainage. Thirty curb inlets spaced at approximately 300-ft. intervals on both sides of the road collect gutter water and discharge into transverse spillways or drains down the sides of the embankment. Three of these embankment spillways discharge relatively near the Miami River and have free outlets with rip-rapped aprons. The other 27 outlets discharge into stone masonry sumps on the side of the em-



Temporary Wooden Trough for Checking Gullying

bankment away from the river or at long distances from the river on the river side. As the entire embankment and its environs are underlaid with gravel, no difficulty has been experienced in removing surface water in this manner. Near one end of the project two additional catch-basins drain into a longitudinal storm sewer which in turn discharges into a small tributary stream. There are no transverse drains or cross culverts through the embankment under the pavement.

Insofar as possible drains and sumps were standardized. All curb inlets are State Standard No. 3 catch basins. Sumps of stone masonry have an internal diameter of 4 ft. and depth of 6 ft. Except for the top few courses the stone is laid up dry to provide maximum perviousness. Similar in appearance to manholes, sumps are equipped with State Standard No. 1 light-weight manhole castings and grate covers and also with manhole steps. All slope drains are 12-in. diameter Armco paved invert pipe; the same type pipe in 12 and 18-in. diameters is used for the longitudinal storm sewer. Slope drains



Plan of Catchbasin and Special Sump; Also Typical Profile

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Outlet End of Embankment Spillway and Sump

with free outlets are provided with grouted rip-rap aprons flared from a width of 6 ft. to 10 ft. in a length of 12 ft.

Traffic was maintained during widening and drainage operations. Work was supervised by J. S. Paxton, Resident Engineer, under the general supervision of W. E. Willard, Division Engineer of Division No. 8, Ohio Department of Highways.

Road Building Record Made in 1937

More than 22,000 miles of all classes of highway were brought to completion in the fiscal year 1937, according to the annual report of the U.S. Bureau of Public Roads. This mileage, completed under Bureau supervision, exceeded by several hundred miles the work completed in the previous year and also the record of 21,700 miles completed in 1934.

Grade-crossing elimination and protection work in 1937 far surpassed that of any other year. There were 1,149 crossings eliminated, of which 1,086 were financed under the \$200,000,000 grade-crossing program authorized by the Emergency Relief Appropriation Act of 1935. Also, 196 existing grade-separation structures were reconstructed and 574 crossings were protected by signals or other safety devices.

Of the completed mileage, 18,768 miles were constructed with funds apportioned to the states according to formulas prescribed by law and the work was done in cooperation with state highway departments. This work included 10,257 miles on the federal-aid system outside of municipalities, 1,093 miles of extensions of the system into and through municipalities, 571 miles of secondary roads in municipalities, and 6,847 miles of secondary roads outside of municipalities. Federal funds involved in the respective classes of work, including that at grade crossings, were \$155,281,958, \$59,688,908, \$27,380,225, and \$77,281,776.

Roads under contract at the end of the year totaled 11,274 miles and involved \$268,445,582 of Federal funds; and there were 2,074 miles approved but not yet contracted for involving \$36,542,365 of federal funds. Unobligated balances available for new work totaled \$232,053,608, in large part newly apportioned funds for the fiscal year 1938.

Improvements were completed on 139 miles of the forest highway system, exclusive of work done in further im-

proving surfaces previously placed, bringing the total forest road mileage improved to date with federal funds to 6,593 miles. Of the mileage improved during the year, 108.6 miles were in the Western states and Alaska, and the remaining 30.4 miles were in the forests of 19 Eastern states. Of the total mileage improved to date, 5,983.2 miles are in the West and 609.5 miles are in the East.

In the national parks, parkways, and monuments, 169 miles of roads were completed during the fiscal year, bringing the total to 1,293 miles. In addition, there were completed 246 miles of roads in public lands, 26 miles of flood damaged roads, 1,532 miles of roads in special areas to provide work relief, and loan-and-grant projects initiated by the Public Works Administration totaling 1,415 miles.

Work on the Inter-American Highway, extending from Nuevo Laredo on the Texas border to Panama City in Panama, has continued with increased momentum. Impassable gaps have been reduced to about 560 miles. During the year the United States has assisted in the construction or planning of about 50 miles of road and 9 bridges that will remove major obstacles to development of this important route. This was made possible by the congressional authorization of \$1,000,000 made in 1934 for cooperation in the survey and construction of the highway. The total length of the highway will be 3,250 miles.

The present condition is as follows: 1,265 miles of all-weather roads, mostly paved or being paved (including 765 miles from Nuevo to Mexico City and 300 miles from Panama City to David, both important to the United States as contiguous to Texas and the Canal Zone); 1,425 miles of dry-season roads, mostly impassable during the rainy season; and 560 miles of trails, impassable to wheeled vehicles at any time.

The Bureau has also continued its highway research studies, concentrating especially on the study of cheap but lasting road surfaces, and on highway safety promotion.

Continuing the policy of the past 4 years, all highway work was administered with employment of those on relief rolls as a primary objective. The nine different classes of work supervised by the Bureau provided a total direct employment in the fiscal year 1937 of 1,792,760 man-months, slightly exceeding that of the previous year but less than the peak years of 1934 and 1935. In direct employment, on all Federal and State highway construction and maintenance, the total man-months were 3,755,491.

Emergency funds available for new projects were reduced to a small remainder at the end of the year. Considerable emergency work under construction was carried over into the new year and when this is completed, the emergency program will have been practically concluded.

While the end of the year marked the last stage of the emergency road-construction program, it also marked the beginning of a broadened Federal-aid program, with \$125,000,000 for improvement of the Federal-aid system, \$25,000,000 for secondary or farm-to-market roads, and \$50,000,000 for elimination of hazards at grade crossings in each of the fiscal years 1938 and 1939. Funds for Federal-aid and secondary roads must be matched by the states, but the funds for elimination of crossing hazards are direct grants.



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THAT GRIPS BETTER
AND LASTS LONGER**

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CALCIUM CHLORIDE treatment of ice control materials has brought peace of mind to road officials the country over. For road men know that, when calcium chloride treated grits are spread on icy surfaces, they are there to stay. Neither traffic nor wind can make them lose their grip.

Zero temperatures and below? They don't mean a thing. No "fair-weather friend", calcium chloride treatment is just as effective at 50 degrees below as at 32 above.

One thin application of treated grits gives more protection than three of untreated materials, and the treatment makes them stay on the road four times as long. So, it's actual economy to treat all ice control materials

with calcium chloride. In fact, it costs money not to treat.

Full information and literature on practical ice control methods will be gladly furnished by any of our Association members. Write for it now.

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CALCIUM CHLORIDE
FOR BETTER ICE CONTROL

A 4½-MILE RELOCATION JOB IN MINNESOTA

A 4½ MILE highway re-location job in which the grading, finishing, sloping and even bulldozing the dirt in and around the culverts were all performed with motor graders, assisted by crawler wagons and a shovel, has just been completed on state highway 36 immediately outside of Minneapolis and St. Paul, Minnesota, by J. J. and M. S. Mergens, more familiarly known among Minnesota contractors as "Joe and Mike." Otto Hofmann was superintendent in charge.

The Mergens brothers, who are primarily dirt movers, and are well known throughout Minnesota and the Dakotas, use an Austin-Western 77 dual-drive machine as their chief piece of equipment on the job, which called for grading, construction of drainage structures and the laying of the stabilized surface, on the highway, which runs from Rice St. and the Ramsey county line.

Grading work began in October of 1936, and between that time and July 1st, 1937, 290,000 yd. of dirt were moved, an additional 40,000 to 42,000 cu. yd of top soil being placed on the slopes in 6-in. layers.

Between July 1 and Aug. 1, 1937, the contractors spent their time stock-piling the clay that was to be used in building the stabilized surface. As this clay came out of the pit it was in stick, gummy slabs that had to be dried and pulverized before they could be used. A regular farm pulverizer was employed for this purpose.

The first week in August Mergens brothers began putting down the stabilized surface, and finished it about the first week in September. On half the road this surface was put down in two courses, the lower or base course



Austin-Western Motor Grader, Leading the Procession, Followed by Tank Truck and Three Loaded Trucks Used for Rolling. In the Background Are Flat Slopes of One of the Cuts Finished by the 77.

being 3 in. thick with a 3-in. wearing course on top. The other half of the road was built with a stabilized subgrade, on top of which was placed a 3-in. wearing course. The method of construction utilized the full power of the motor grader for mixing. The binder-soil and sand were first put down in separate windrows and then mixed. This operation assisted in further pulverizing the soil. The gravel was then hauled to the job and put down in a flattened windrow and the mixed sand and clay were pulled over the gravel with the blade. The gravel in the base course was minus 1¼ in.

Mergens brothers then proceeded with the preliminary mix, which consists of working the mixture of clay, sand and gravel back and forth over the road for a period of approximately 18 hours to each half-mile of road. In this method, after the material has been thoroughly mixed it is spread out in 1-in. layers, which are sprinkled and rolled. While the amount of water to be used is definitely stated in the specifications, there is a great variation in the amount used in actual practice, due to weather conditions. When the weather is hot and dry, the specified amount of water is not nearly enough, and during periods when there are frequent showers very little water need be added. These particular problems were solved satisfactorily through close cooperation between the resident engineer and the contractors.

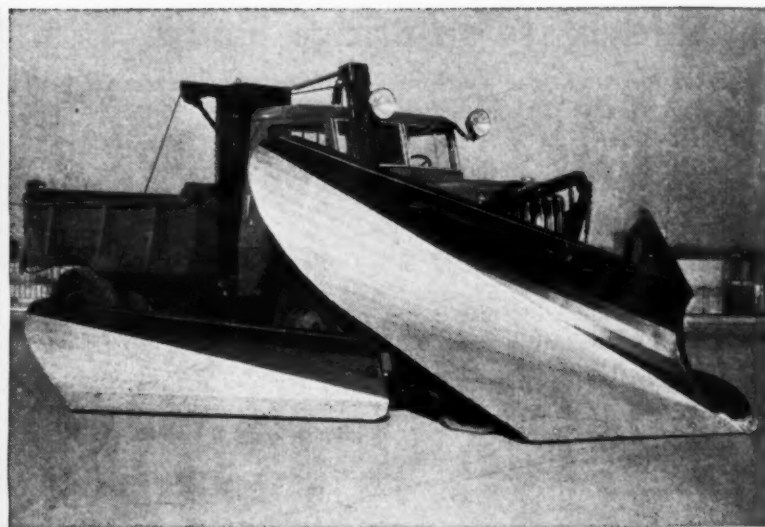
The surfacing course was laid in the same way as the base course, except that the gravel was minus ¾ in. and calcium chloride was added when the material was about three-quarters mixed.

Rolling was done with trucks, of which four were used. Two homemade 1200 gal. water tanks were used for sprinkling, each being mounted on a truck, and being capable of sprinkling a 5 ft. strip slightly longer than a mile. Water for this purpose was obtained from the city mains, since the job was just outside the city limits.



Left to Right: Mike Mergens, Otto Hofmann, Superintendent, Joe Mergens

MAKE NO MISTAKE YOU NEED Walter 100% Traction For Snow Removal



HAVE you ever seen a team of horses slipping on an icy pavement, unable to move a load that they could run away with under ordinary conditions? They have plenty of power but no traction.

The same thing often happens to snow removal equipment working after a heavy blizzard. A wheel loses traction and begins to spin, while its mate stops dead—all the power leaking out through the spinning wheel. In a rear wheel drive truck this is enough to stall it. In an ordinary four-wheel drive, two wheels, one front and one rear, losing traction at the same time will stall the truck.

The WALTER SNOW FIGHTER, on the other hand, can only be stalled if all four

wheels lose traction at once. For the Walter is not merely a four-wheel drive—it is the only truck that has four-point positive drive. Correct differential action between all wheels, front and rear, right and left, is provided by three automatic locking or power proportioning differentials. These divide the power so that the wheels with least traction get the least and those with most traction the most power. This super-traction insures a positive drive on all four wheels on slippery ice and snow-covered roads.

Many times you will be glad you have Walter Four-Point Positive Drive—or you will wish you had it.

■ Send for Literature ■

WALTER MOTOR TRUCK CO.

1001-19 IRVING AVE. RIDGEWOOD, QUEENS, L.I., N.Y.

Skid Tests on Bridge Floors

Tests to exhibit the skid-proof qualities of open mesh steel decking on bridge floors were conducted by City Manager John N. Edy of Toledo, Ohio, November 7, 1937. On the Cherry Street bridge two race drivers in stock cars were moving about 35 or 40 miles an hour when, without warning, the man ahead shoved hard on his brakes. The rear car driver, 15 or 20 ft. behind, slammed down his brakes, of course, to prevent striking the car ahead. He skidded some, but the notable point is, that the skidding was straight ahead. On the next run, traveling at about the same clip, the rear driver, instead of slamming on his brakes, jerked his vehicle to the side and went around the head car. Ordinarily, at the speed they



Showing Driver of Rear Car At Instant of Stop on Straight Ahead Skid on Open Mesh Decking.

were traveling, the rear car would have skidded clear to the bridge hub rail, but instead it clung to the maneuvered course and never slipped at all. The demonstration was quite spectacular and forceful, especially if one has ever personally experienced this common type of accident condition.

To show, by comparison, what the effect would be on a solid decked bridge floor, the demonstration, locale was removed to the St. Clair Street bridge. Here, the front car driver, when he shoved down on his brakes, skidded sideways. The following driver, having only one chance, slammed on his brakes, and, skidding differently, crashed the forward car in the middle of the right side. The test was repeated to give the rear driver an opportunity to avoid a crash by jerking his steering wheel. The result was another disastrous crash in which both cars skidded



Head Car Out of Control and Rear Car Beginning to Skid As Rear Driver Slammed on Brakes on Smooth Deck Flooring. Photo Snapped an Instant Before Crash.

out of control. The wet bridge floor of the St. Clair Street bridge probably eased the striking blow because the cars merely kept skidding after the impact.

The Toledo Traffic Safety division made good use of the demonstration as a training problem. After the crash, the safety and first aid trucks rushed to the scene. First aid was applied and the drivers theoretically rushed to a hospital. Several newsreel cameramen and newspaper photographers were on the job.

Certainly one fact was demonstrated, that is, that open mesh steel decking on bridge floors is far more skidproof than smooth floor decking.

Taxi drivers, business men and citizens, to whom the writer talked spoke highly of the smooth riding of the open decking. One business man who drove across it regularly stated he had not even noticed that it was a different flooring except that it rode smoothly.

The tests were conducted not for unusual accidents or spectacularity, but more to compare behavior of cars in the common type of accident.

▼
USEFUL PURPOSES OF ROADSIDE WEED CUTTING—In a recent statement N. W. Elsberg, Minnesota State Highway Commissioner said that weed cutting serves a triple purpose and ultimately proves to be a definite economy. They are: First, the cutting of noxious weeds eliminates what otherwise would be an ever present menace of re-seeding adjoining farms with weed pests. In the second place, the cost of fall mowing and brushing which is now under way is many times repaid by winter savings in snow removal. Weeds and brush cause roadways to fill up with snow, and their elimination reduces plowing expense in immense proportions. In the third place, mowing and brushing is essential not only for simple highway beautification, but to assure clear visibility on curves and turns and ready readability of traffic warning and directional signs.

▼
NEW MINNESOTA TRAFFIC ACCIDENT REPORT SYSTEM—A new agency for officially recording all traffic accidents in the state of Minnesota in which 'personal injury or property damage exceeding \$50 is suffered has been put into effect. The state highway commissioner is charged under the new uniform traffic code with the duty of both zoning the highways and directing the state traffic accident reporting agency. The new agency has been developed so as to permit safety officers to find, in a few minutes, the number of accidents in which a driver has been involved and also to determine the accident count at any spot on the state trunk highway system and in the cities. The present filing system is built on the "cross-check" basis and exposes at once "accident prone locations" and "accident prone drivers."

▼
PROGRESS ON GERMAN NATIONAL AUTOMOTIVE HIGHWAYS—Of the extensive network of national automotive highways ("Reichsautobahnen") at present under construction in Germany, further 147.7 kilometer stretches were opened for traffic during the month of June, 1937, thus increasing the total length of highways actually in operation at the end of that month to 1,382 kilometers. Under construction on July 1, 1937, were about 2,026 kilometers. An average of 97,128 workmen was being employed on this vast project during the report month, as against an average of 95,525 in the previous month.

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BETHLEHEM is in a position to supply you with every form of road steel you need to build or repair concrete highways and will get your steel to you as you need it regardless of the location of the job. That means the work is not subject to delay while you wait for shipments of road steel to arrive.

This gives you the opportunity to get rid of one major source of worry and much detail work of checking on shipments. A wire or 'phone call to the nearest Bethlehem district office will bring you the details of Bethlehem Road Steel Service.

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EDITORIAL

An Open Letter to the President

HON. FRANKLIN D. ROOSEVELT,
President of the United States,
Washington, D.C.

Mr. President:

Before me is a clipping from a Chicago newspaper which states, in part, as follows:

"In discussing the message which will seek to curtail highway allotments, the President said that up to 1929 and 1930 the government had been giving the states between 80 and 90 million dollars for state aid roads, and allotments have now grown to 200 million dollars.

"That, he said, is a grant which should be cut down because the main arteries are in good shape. * * *

* * *

"The proposed message curtailing highway funds was seen as a direct result of the recent speech of Secretary of Treasury Henry A. Morgenthau. * * *

Exception is taken to your excuse for desiring to curtail highway expenditures. Were you to follow me for a year on the main highways of this vast land of ours you would soon change your mind about the main arteries being in good shape. I covered about 35,000 miles of main arteries this past year and I tell you they are not in good shape. Many are not even surfaced, many are obsolete to the degree that they are dangerous. The mounting death toll testifies to that fact. Many are inadequate to handle the weekend traffic.

May I suggest that you and the Secretary of the Treasury drive the highways of this country to get some first hand information. If and when you go leave your big limousine in Washington and use the average man's \$700 to \$900 car. Make a circuit through the South, Southwest, Rocky Mountain States, Montana and the Dakotas and return on most any east bound route from Chicago back to Washington. It would be nice if you could hit Kentucky, Tennessee, Arkansas and other states inside of the suggested circuit. When you returned, you would probably have done some Sunday driving, some night driving and some rainy weather driving. Half way around you, also, would wonder why there were so many rough, obsolete, and unsurfaced roads. Then remember this, the people expect these roads to be improved. They are paying their motor vehicle and accessories taxes, gas taxes and license fees without complaint because they know they are getting roads. Right now the federal income from motor vehicle and fuel tax collections exceeds the appropriations for highway work.

To cut down the allotments, instead of increasing them, and using the funds for other purposes, will constitute a *direct diversion* of them in betrayal of the people's confidence that they would be used for highway construction. Furthermore, such action would not be in accord with the policy established by the Congress for state funds as outlined in Sec. 12 of the Hayden-Cartwright Act.

You and I know the people are not getting all the roads for which they are now paying. We know millions of dollars of this highway money is being diverted to other uses than highway purposes. But that's getting away from my principal complaint.

There's more to this vast domain over which you reign than the territory of the thirteen original colonies. You and your treasury secretary should cross the Appalachian, Catskill or Adirondack Mountains some day, out into the wide open spaces, the best of the land, and see for yourselves the urgent need for more and better main arteries. Drive long and keep up with the normal traffic. You can't judge a highway from a private railroad coach.

Right in Washington you have a man who knows the actual conditions. He's on your pay roll, and heads up the best, most efficient highway administrative organization in the world, Mr. T. H. MacDonald, Chief, Bureau of Public Roads. Why not call him into your office for a two hour session some day? At least, read his annual report. Had you done this I doubt if you would even *think* of cutting highway allotments, much less state that the main arteries are in good shape.

May I suggest that these main arteries have National Defense value? Federal aid in greater proportions than heretofore authorized is justified on that value *alone*.

Lastly, may I suggest that you follow the suggestions of highway engineers who know the conditions in preference to following the suggestions of our treasury secretary?

Very truly yours,

V. J. BROWN,
Publishing Director, ROADS AND STREETS.

▼

Be There

WHEN members of the American Road Builders' Association meet in Cleveland, Jan. 17 to 21, for their 1938 Road Show and Convention, they will be carrying on for the thirty-fifth time an activity that was started at a time when the automobile offered only minor competition for the horse. Be at Cleveland at the next convention and see the tremendous change. For many years after the association was organized the conventions were meetings of a small number of men interested in highway programs. What you will see at Cleveland next January will certainly be different from that. So many long strides in new developments in designs, theory, maintenance and construction methods, and equipment have been made in the past year that the live, professional engineer and contractor cannot afford not to come. So we urge you to attend the convention at Cleveland. PS—Telegraph your Congressmen to oppose the reduction of federal aid for highway programs as proposed by President Roosevelt.

BUCYRUS-ERIE SCRAPERS ARE RATED AT LEVEL CAPACITY



**BUCYRUS
ERIE**

EXCAVATING, DRILLING AND MATERIAL HANDLING
EQUIPMENT, SOUTH MILWAUKEE, WISCONSIN, U. S. A.

Safety First, Mr. President

THE President is to be praised for his program of reduction in government expenses. But when he urges drastic curtailment of highway expenditures he overlooks two important facts. The first of these is that the users of the highways pay for that use in the form of special taxes, and that any reduction in governmental expenditures for highway improvement is equivalent to a diversion of the gasoline tax and the like to other uses. The second fact that he overlooks is the desire of the motoring public to continue the improvement of the highways on a scale comparable to their personal expenditures for motor vehicles and their operation.

If the highway users had cut in two their annual outlay for improved motor cars, then the President would be safe in inferring that the public desires a corresponding reduction in the annual budget for road improvement. The contrary is the case. Each year witnesses huge purchases of better cars. Their higher speeds call for wider roadways, elimination of grade crossings, easing of curves, highway lighting and all the construction improvements by which safety can be increased.

Every two years as many Americans are killed in highway accidents as were killed by bullets in France. No more certain way of reducing this slaughter has been found than by rebuilding our highways to suit the conditions that have developed. Of these new conditions, three are outstanding, namely: (1) greater speeds, (2) greater congestion and (3) a larger percentage of reckless, youthful drivers. It was hoped that safety propaganda would offset the ill effects of these new conditions, but the hope was vain. Safety must be built into the highways and that costs money. Fortunately the users of the highways are willing to pay that cost without a murmur. But they will more than murmur, Mr. President, if you continue to urge the diversion of the federal gasoline taxes to uses foreign to this safety campaign.

Economic Freedom

IN THE November issue of *Roads and Streets* we quoted at length the opinions of an unnamed writer on "Economic Readjustment." His economic theory is the antithesis of a theory of economic freedom for he advocates governmental control both of wages and profits. Such theories have attracted many advocates since the beginning of history, and they have been put into practice again and again, but never with the beneficial results that had been anticipated. On the other hand, the peoples who have enjoyed the greatest economic freedom have also enjoyed the greatest prosperity.

Economic restrictions have not always been those imposed by governments. For example, the ancient craft guilds were often more severe in their economic restrictions than were the governments of those servile days. And to this very day the severest of all economic restrictions are those imposed by the castes of India upon their members and upon all who employ or deal with them. It takes six Hindu servants to perform the various functions

of service for the smallest family, and all six earn less than one American laborer. They earn less because they produce less, and they produce less because their caste permits no more.

Americans have always enjoyed not only the greatest political freedom but the greatest social and economic freedom, with results that need but to be studied to convince an unbiased mind that the old "laissez faire" economists were fundamentally right. In this free country within a century the annual real income of the average worker increased four fold. In Russia, with equal natural resources, but without such freedom, little economic progress was made in a century, and the last 20 years shows no marked improvement, for although a radical change in governments has occurred, economic freedom is still a dream.

Federal Super-Highways

ONE of the policies of this magazine is that of advocating and promoting a purely federal highway system. At the last Congress no less than eleven bills were introduced which in one way or another offered this same idea. We now have reason to believe that President Roosevelt is becoming interested, and rightly so, in a super-highway plan for the North Central and Middle and North Atlantic States. These are the heavy populous areas. Perhaps he has taken time to reflect upon how slow travel has become in these areas.

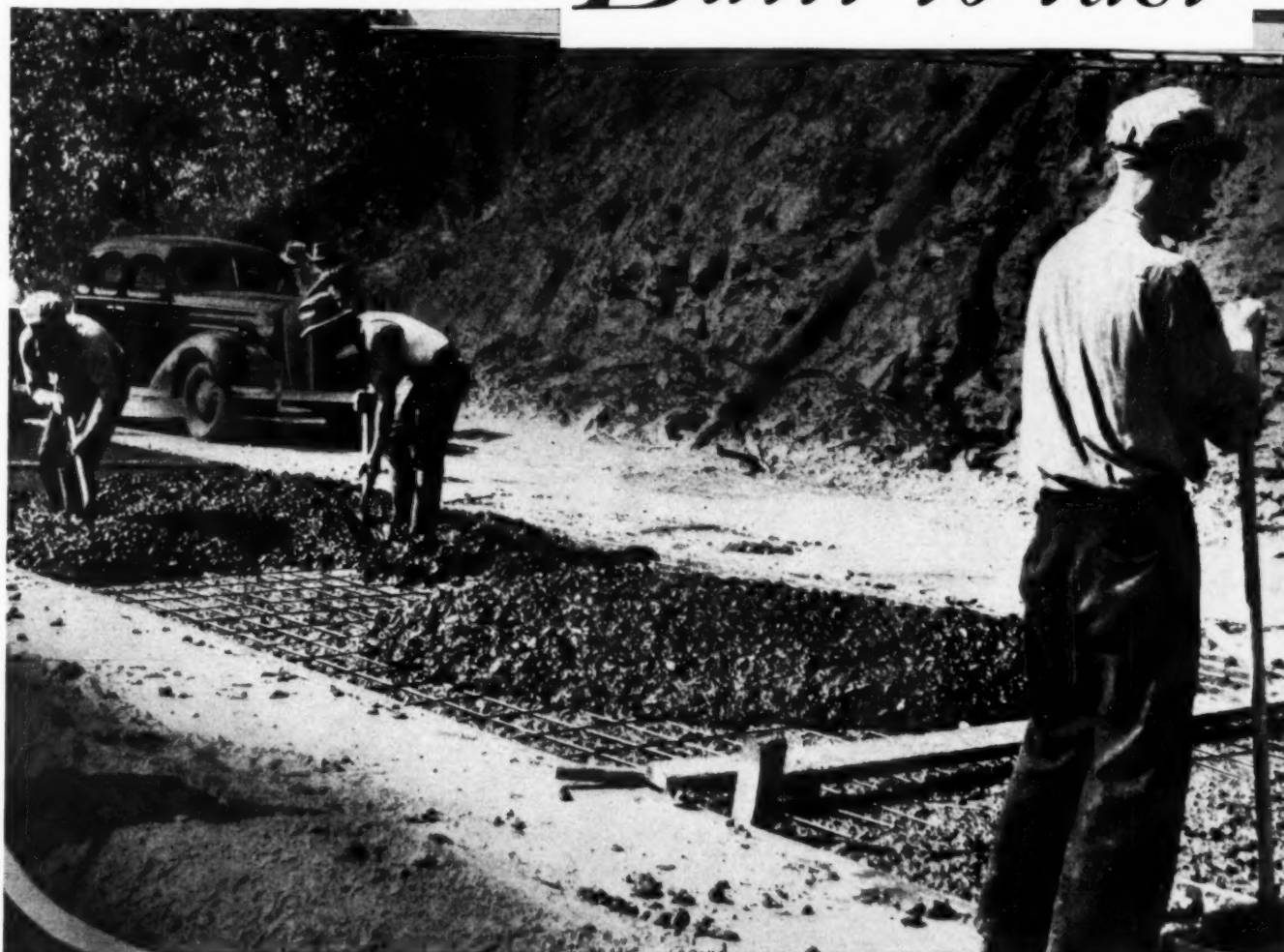
Not only would a super highway system there be advantageous from a national defense point of view, but it would be advantageous to serve as a nucleus of a federal highway system for connecting national recreational areas, forests, parks, historic sites, and vacation spots. One needs only to take a Sunday drive to the Blue Ridge parkway and return to see how useful such highways will become. Washingtonians (D.C.) who desire to make the drive leave the District early in the morning in order to avoid the jammed highways that lead out and back. They strive to return early for the same reason.

A super highway from Washington to Boston and one from Chicago to New York or thereabouts to tie in with the first should allow ingress and egress only at long intervals, 5 miles or more. For the sake of safety and permissible high speed, all railroad and highway crossings should be separated. Vertical and horizontal curvature should be designed for 100 or 120 mile an hour motor vehicle speeds. Commercial truck traffic should be prohibited.

Such a project is worthy of study. It is probable that it could be made self supporting by toll charges.

MOTOR TRANSPORT INDUSTRY PAID MORE TAXES THAN RAILROADS—Not counting the taxes paid on personal property, income tax and property taxes on garages, terminals, repair shops, etc., the motor transport industry in 1936 paid as so-called "Special Truck Taxes" the sum of \$383,563,000. The taxes of the Class I railways for the same year totaled \$319,752,721.

HERE'S A HIGHWAY

Built to last

NEW highways cost a lot of money and their upkeep can be expensive too. But you can build concrete highways worthy of their cost and you can put off the day when repairs will be necessary if you use American Steel & Wire Company Wire Fabric.

Wire Fabric when used in highway construction gives the concrete a unity of structure that effectively

resists the common forms of depreciation caused by weather and temperature conditions. It also gives additional strength against settling and overloading. Many of the small cracks that play havoc with highways are prevented where wire fabric has been used and in cases where cracks do appear in the concrete, wire fabric keeps them from spreading.

American Steel & Wire Company

Wire Fabric is a product you can rely upon to give you the best of service. It is made from high-yield-point cold drawn steel wire. It is obtainable in square, rectangular or triangle mesh to suit your particular needs and may be had either in rolls or in sheets. To save many dollars in maintenance costs be sure to use Wire Fabric to reinforce concrete in highway construction.

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UNITED STATES STEEL

NEW EQUIPMENT AND MATERIALS

New 1½ Yard Shovel

The Lima Type 650, a convertible shovel, crane or dragline, has been announced by the Lima Locomotive Works, Inc., Lima, O. When used as a shovel it is equipped with a 1½-yard dipper, 21-ft. boom and 17-ft. dipper handle. The shovel boom is the box type design, electrically welded throughout. The dipper handle is of the same modern construction. The Type 650 is available with either

New Gasoline Engines

Two new models of gasoline engines have been announced by the Buda Co. of Harvey, Ill. These models are known as the M-707 and M-766. They are 6-cylinder engines with overhead valves. The M-707 has 707 cu. in. displacement with a 5 in. bore and 6 in. stroke. The M-766 is 5½ in. x 6 in. and has 766 cu. in. displacement.

Crankshafts are 3½ in. in diameter, with seven main bearings, and connecting rods are 12½ in. center to center. All crankshaft and connecting rod bearings are the replaceable "precision" type. Lubrication is by positive force feed pres-

D4. The Trackson high shovel is regularly equipped with a ¾ yd. bucket. Advantages claimed for this machine are: a fast mechanical hoist which is not affected by weather temperature; independent front end drive; free dumping of the bucket at any point of the lift; automatic release when bucket reaches maximum height; full visibility for the driver; and many other features. The "Caterpillar" tractors to which this shovel is adapted are specially equipped with wide gauge, extra length (5-roller type) rigid track frames, front power take-off and blower type fan. Further details may be secured from Trackson Co., Milwaukee, Wis.



The Lima Type 650 1½ cu. yd. Shovel, Convertible to Dragline or Crane

a gas, Diesel, oil or electric power unit. Only three levers and two foot pedals are necessary to control the three major operations, hoist, swing and crowd. Each major operation is independent of the other, which makes it possible to hoist, travel, swing and raise or lower the boom simultaneously. The drum laggings are split and are easily changed to fit any line speed. Helical cut gears are used throughout to assure smooth, quiet operation. To further the efficiency of the Type 650, roller bearings are used at every vital bearing point.

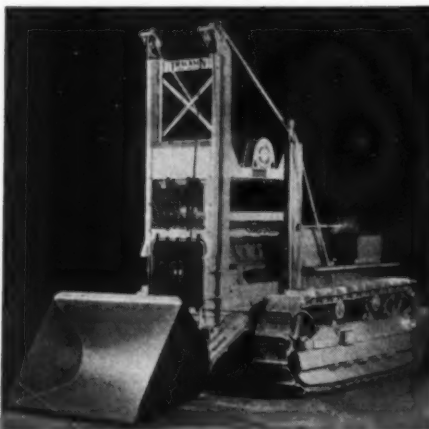
The crawler truck is composed of a one-piece base casting with four through axles on the ends of which revolve eight open type self-cleaning rollers. It is of the end drive principle with drive chain located back under the crawler treads. Steering is accomplished with the upper frame at any position, which is an advantage when propelling in close quarters. The crawlers are so designed that they can be extended in length to increase the ground bearing area. The change from short crawlers to long crawlers can be made without dismantling the machine. The cab has an in-built winter front of shatter-proof glass. More than one-half of the area of the cab can be opened to give ample ventilation in hot weather.

sure to all crankshaft, camshaft, connecting rod and piston pin bearings and to rocker arm shafts and timing gears.

The M-707 and M-766 are built for various types of installations including shovels, cranes, draglines, hoists, heavy duty trucks, stationary and portable compressors, pavers, crushers, locomotives and rail cars.

Trackson High Shovel Now Available on Caterpillar Tractors

The Trackson high shovel is now available on "Caterpillar" Tractors R4 and



Trackson High Shovel on Caterpillar Tractor

Snow Plow and Tractor by City of Minneapolis and Minneapolis-Moline Power Implement Co.

The City of Minneapolis is providing twelve new sidewalk clearing units against an anticipated hard winter. One of these—here pictured—was displayed at the Minneapolis Auditorium when the Labor Temple Association held its annual harvest festival in November. The plow was designed and built by the Engineering Department of the City of Minneapolis, while the tractor is the new Industrial "Z" of the Minneapolis-Moline Power Implement Co. The engine in this unit has all the features of the Universal



Minneapolis' New Sidewalk Plow and Tractor

Visionlined "Z" farm tractor, including the transmission with five forward speeds. The snow-moving unit is equipped with starter, generator, battery, headlights, tail light, and horn. Hydraulic lift is operated from the driver's seat and may be raised or lowered without stopping the tractor.

New 3-Ton Truck

A new 3-ton cab over engine truck has been added as a standard unit to the line of the Dodge Division of the Chrysler Corp. This new unit is built for heavy duty work and permits a longer body on a given wheel base length, or a shorter over all length when it is used as a tractor for pulling semi-trailers and trailers.

The engine has six cylinders and is of the L-head type, with 3¾ in. bore and a 5 in. stroke. Piston displacement is 331.34 cu. in. and develops 100 h.p. at 2800 r.p.m.

Frame of this new 3-ton unit is of hot rolled steel 5/16 in. thick and 8 9/32 in. in maximum depth. Width of the flange of the frame steel is 2 7/8 in. Width of a standard frame at the rear is 34 3/16 in. and varies in length, according to the

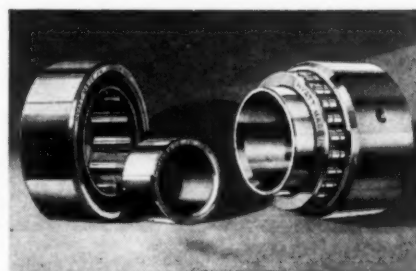
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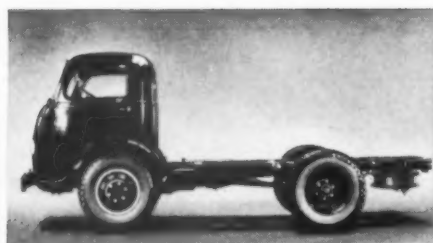


MACHINERY MANUFACTURERS build in Hyatt Roller Bearings with the utmost security. They know Hyatt Roller Bearings protect vital working parts against shocks, wear and misalignment. Years of successful experience have proved to them that these dependable bearings help extend equipment life and assure smoother, quieter, and more efficient operation with less care.

Thus does Hyatt protection—the result of correct bearing design, precision manufacture, and sound application by Hyatt engineers and craftsmen—generously contribute to industrial progress. Hyatt Bearings Division, General Motors Corporation, Harrison, N. J., San Francisco, Cal., Hyatt Roller Bearings Sales Company, Chicago, Ill., Pittsburgh, Pa.

↑ Look for Hyatts in the equipment you buy. In this Single Cable Scraper built by the Moore Equipment Company and sold by **AUSTIN-WESTERN** the Sheaves are all Hyatt equipped.





New Dodge 3-Ton Cab-Over-Engine Truck

wheel base. Standard wheelbase lengths offered are 96 in., which has a frame length of 182 19/32 in.; 108 in. wheelbase with a 219 3/32 in. frame; 122 in. wheelbase with a 233 3/32 in. frame and the 140 in. wheelbase with a frame of 251 3/32 in. length.

Transmission of this model provides five forward speeds and one in reverse, with the following ratios in each: First, 7.58; second, 4.38; third, 2.395; fourth, 1.478; fifth, direct, and reverse, 6.10. A power take-off opening is located on the right side of the transmission.

Rear axle housing is a single piece of welded square steel tubing. It has a road clearance of 10 1/4 in. when 9.00/20 tires are used. The rear axle is full floating and is offered in the gear ratios of 7.4, 6.8 and 6.166. Double reduction axles with 8.4 ratio and two speed axles with ratios of 6.14 and 8.35 also are available as extra, or optional equipment.

New 1 1/4 Yd. Power Shovel

The 33-B, a 1 1/4-yd. excavator convertible for shovel, dragline, clamshell, crane, or dragshovel service has recently been announced by the Bucyrus-Erie Co., South Milwaukee, Wis. Modern alloy steels and welded construction have been used to produce a machine that combines smooth working operation, high speed,

high mobility, and ample strength to give steady dependable service in the heavy digging expected of a machine of this size.

The 33-B has many unusual features which warrant special attention. A few of them are:

Unusually long caterpillar frames to reduce "nosing in" when digging.

Caterpillar side frames of unit steel castings.

Welded box-girder boom, light weight for speed, strong for endurance.

Powerful, modern hoist and chain crowd.

Dipper having manganese steel casting, "V" type front, with sockets for Bucyrus-Erie patented inserted teeth and having curved plate door.

All high speed shafts operate on ball or roller bearings.

Snappier swing action and high speed output as a result of elimination of dead-weight.

Big wide-faced clutches that take hold smoothly and firmly and hold adjustments accurately.

Simple lubrication. Vital points cared for by complete enclosures containing oil.

In the 33-B, power rides on anti-friction bearings direct to the point of action. A choice of three different types of power is offered: Gasoline, diesel, or electric.

For further particulars and specifications write for the 33-B bulletin, available upon request made to the Bucyrus-Erie Co., South Milwaukee, Wis.

Stone and Chip Spreader

A stone and chip spreader, a product of the Temple Stone & Chip Spreader Co., 2335 Kutztown Road, Reading, Pa., is illustrated. The spreader consists primarily of a steel hopper with gear control gate and operator's approved safety



Model A Temple Spreader

seat. The spreader is designed to replace the tail-gate on any dump truck. It is readily attachable and detachable without any alterations to the motor truck body. It requires only five minutes to change from body tail-gate to spreader.

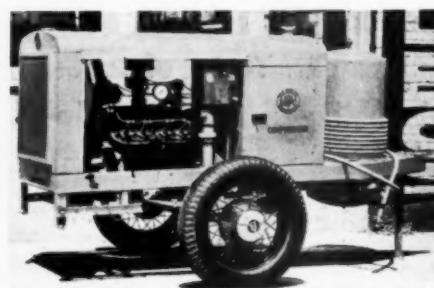
The spreader will properly spread sand, stone, chips, slag and gravel at any desired rate per square yard, covering any width 6 in. to 8 ft. with truck moving forward or backward, regardless of truck speed. The operator has full control of spreader from the operator's seat. No power mechanism is necessary for spreading materials.

The spreader is substantially constructed of heavy steel plates and cast steel fittings, properly braced and reinforced, with a truss rod and turn buckle on under side of spreader, for taking up any sag, keeping opening of spreader uniform at all times. Controlling device is simple, durable and readily adjusted. Control gate of spreader 8 ft. wide and 9 in. high.

New High Speed Portable Air Compressor

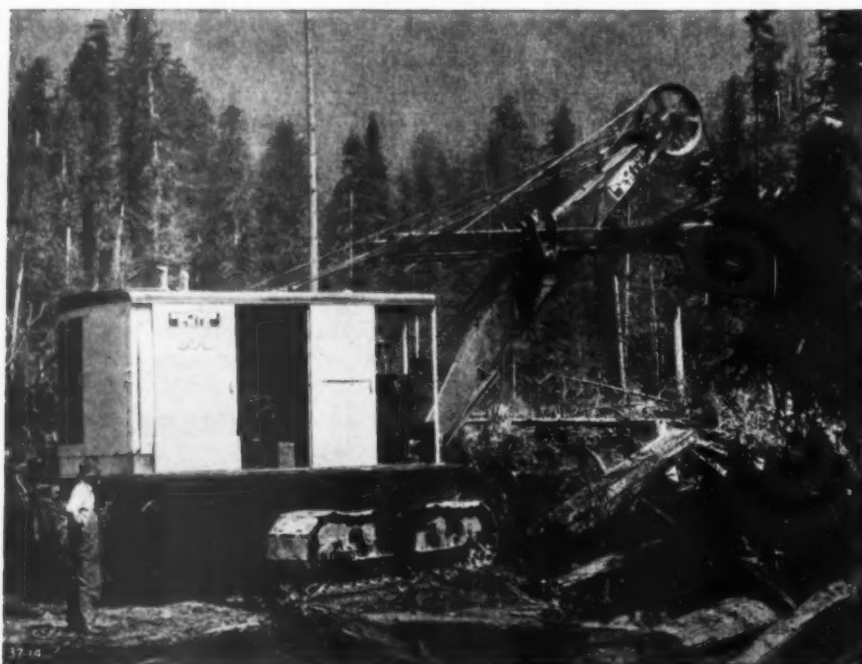
A new light weight compressor for all types of construction where pneumatic tools are used, has been announced by the W-K Mfg. Co., 231 Southwest Blvd., Kansas City, Mo.

There are two sizes available in W-K



New Portable Air Compressor

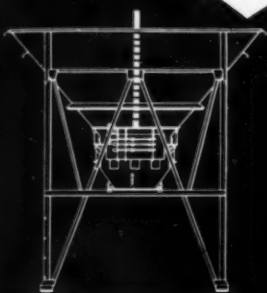
Compressors, 70 and 140 cu. ft. actual delivery. Two Ford V-8 Engines are utilized in the construction of the larger Compressor. One V-type engine only is used in manufacture of the "Utility" or 70 cu. ft. machine which weighs only 1300



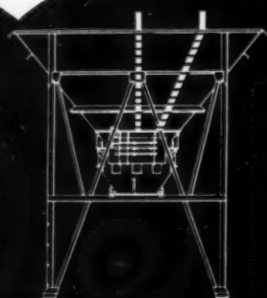
Bucyrus-Erie 33-13 Excavator

ONLY

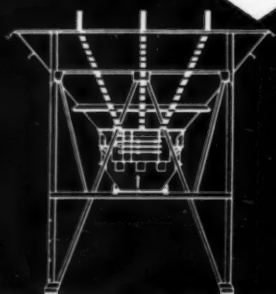
YOU BUY THIS 2
COMPARTMENT BIN



ON YOUR NEXT JOB YOU
CAN CONVERT TO A 3
COMPARTMENT BIN LIKE
THIS



...OR A 4 COMPARTMENT
BIN LIKE THIS...



THE ORIGINAL BIN DESIGN
PROVIDES FOR THESE CONVER-
SIONS TO BE MADE RAPIDLY
AND ECONOMICALLY

IN BLAW-KNOX BATCHERPLANTS



you buy

VERSATILITY

Look ahead when you buy a bin and batcher, beyond your present job. Buy a *versatile* Blaw-Knox BATCHERPLANT—convertible to varying needs and specifications—to use on many jobs.

As your requirements change, add bin bulkheads at slight extra cost to suit your aggregate specifications.

The Weighing Batchers you buy originally is designed to accommodate extra weighing beams to meet these changing conditions, the cost of extra weighing beams is nominal.

Only at Blaw-Knox can you buy this changeability in a standard, shipped from stock, Batchersplant—with the added features of self-cleaning bin design; ease of erection; accurate, simple and dependable weighing batchers—and rugged construction to last through a number of jobs.

We will gladly send you complete details.

BLAW-KNOX COMPANY

2001 FARMERS BANK BUILDING

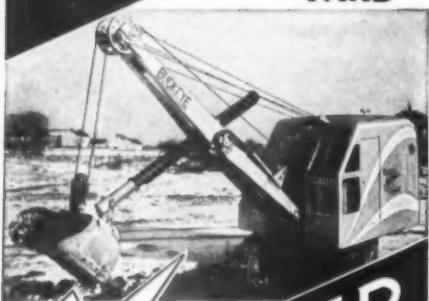
PITTSBURGH, PENNA.

Offices and Representatives In Principal Cities

BLAW-KNOX

The Buckeye Clipper

1/2-5/8-3/4
YARD



METERED
Vacuum
CONTROL

big
yardage

LITTLE EFFORT



Here's a machine that piles up big yardage without calling for marathon endurance from the operator.

METERED VACUUM CONTROL speeds up digging by making every swing of the dipper fast and accurate. Finger tip pressure by the operator commands instant response from the machine.

Convertible
SHOVELS-CRANES-TRENCH HOES
CLAMSHELLS-DRAGLINES
The
BUCKEYE TRACTION DITCHER CO.
FINDLAY, OHIO

1b. One bank of V is used for power and the other bank of four cylinders are utilized for air cylinders.

W-K compressors are designed for portability and may be towed behind an automobile at speeds up to 60 miles per hour.

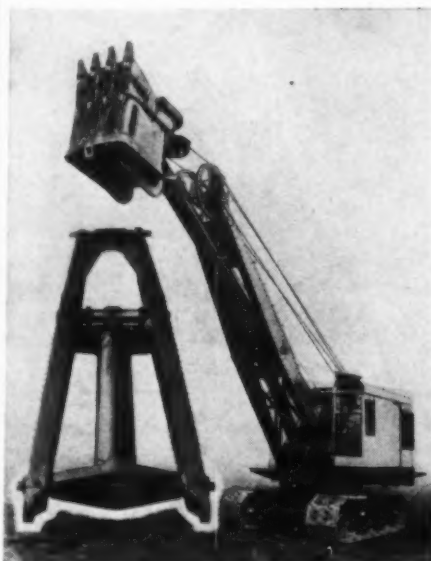
Other special features include: Economical operation; availability of parts in small cities at Ford service stations; "Double Cooled" air valves; electric starter; and 6-volt plug in lights.

A New Development in Shovel Booms

A new shovel boom has recently been developed by The Thew Shovel Co., Lorain, O., for use on its 1 1/2 yd. Lorain 77 and 1 1/4 yd. Lorain 75-D.

Since severe torsional stresses occur in a shovel boom, this boom is based on an actual analysis of these torsional stresses and has been designed with an accurate provision for them in the form of a separate torsional member.

The boom is virtually two booms in one—one a structural member absorbs bending and compression stresses. The other, a torsional member, absorbs and resists boom twisting stresses. Each member is



New Shovel Boom

connected independently to the shipper shaft and boom hinges in such a manner that no torsional stresses can pass through the structural member and no bending stresses can be transmitted to or through the torsion member.

The structural side members of the boom are fabricated of plates and alloy steel angles riveted and electric welded together into a plate girder construction. These members act as a beam and absorb boom bending and compression stresses. These members are fish belly in shape with the deepest and strongest section being at the center at the shipper shaft or point of maximum stress.

Boom twists and torsional stresses are absorbed by a separate torsional member which extends from the shipper shaft to the boom hinges. This member is a seamless tube about 11 in. in diameter. Since torsional stresses are developed in the

boom at the shipper shaft point, the torsional member is fastened to the shipper shaft by means of a cast steel U-shaped yoke. The yoke absorbs the shipper shaft torsional stresses and transmits them into the tubular torsion member, which transmits them to the base of the boom where they are, in turn, transmitted into the boom foot hinges by means of a cast steel crosshead. The torsion member is connected to the yoke and crosshead by electric welding.

The advantages of the cylindrical section are also made use of in the dipper stick of the new boom. Dipper sticks used in these booms are seamless tubes about 11 in. in diameter. All necessary adjuncts to the dipper stick are electric welded to the seamless tubing so that it is free of all rivet and bolt holes. A drop forge steel crowding rack is electric welded to the entire length of the bottom of the tubular stick, greatly stiffening it in bending and acting as a key to prevent it twisting. The dipper stick operates in a barrel-shaped guide which is mounted on the shipper shaft and which is cylindrical in cross section to fit around the dipper stick. It has a rectangular recess at the bottom in which the crowding rack slides, thus forming as a key and keyway to prevent the stick from twisting.

New Sand and Cinder Spreader

The Good Roads Machinery Corporation, Kennett Square, Pa., has developed a small sand and cinder spreader for the purpose of spreading anti-skid mixtures on slippery pavements.

This spreader, the Model "S", is a disk-type spreader, the disk being geared to the single pneumatic wheel on which the spreader is mounted. The method of attaching the Model "S" to the truck is simple, and permits the spreader to operate equally well with the truck going forward or backward. The hopper is made of sheet steel electrically welded, and contains an agitator to insure a steady flow of material to the spinner disk. The frame of the spreader consists of steel angles cross-braced and welded. The entire spreader is very sturdy and compact. It can be easily handled by one man.

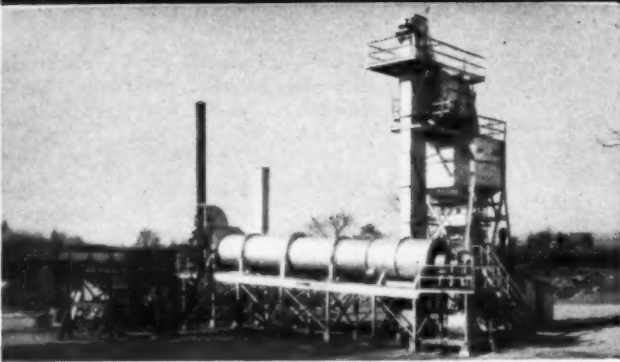
Descriptive literature on the Model "S" Material Spreader can be had by writing the Good Roads Machinery Corporation, Dept. P, Kennett Square, Penn.



The Model "S" Sand and Cinder Spreader



ASPHALT PAVING MACHINERY



The H & B tower type plant combines portability and large capacity. Built by manufacturers of asphalt paving machinery for over 30 years.

Send for our new bulletin T-247

JOT YOUR NAME on THE MARGIN of THIS AD and MAIL IT to US TODAY.

HETHERINGTON & BERNER INC.
ENGINEERS—MANUFACTURERS
INDIANAPOLIS, IND.

Do You Know That--

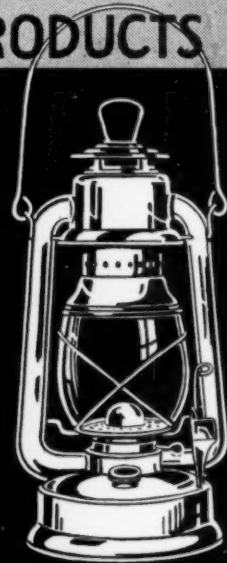


IN CERTAIN SECTIONS OF THE UNITED STATES, RAILROADS FIRST WERE REGARDED AS PUBLIC HIGHWAYS OVER WHICH PRIVATE COMPANIES AND INDIVIDUALS COULD OPERATE THEIR OWN VEHICLES UPON PAYING A FIXED CHARGE.

PENNSYLVANIA, FOR EXAMPLE, GRANTED 20 OR MORE COMPANIES AUTHORITY TO RUN CARS OVER ITS PIONEER STATE OWNED RAILWAY BETWEEN PHILADELPHIA AND COLUMBIA. THE IDEA OF "RAILED HIGHWAYS" APPEARS TO HAVE BEEN GIVEN UP WHEN IT WAS FOUND IMPOSSIBLE TO MAINTAIN SCHEDULES AS LONG AS MANY "INDEPENDENTS" USED THE SINGLE TRACK LINES THEN IN VOGUE.

EMBURY LIGHTING PRODUCTS

BUILT TO GIVE
Real Protection!

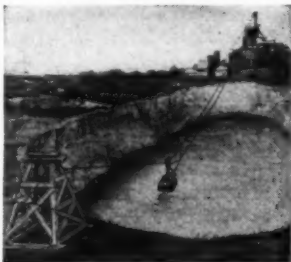


EMBURY MFG. CO.
WARSAW, N.Y.

SUPREME
LANTERNS



Luck-E-Lite
HIGHWAY TORCHES



The picture above shows a Sauerman Slackline Cableway digging gravel from deep under water and lifting the gravel to the top of a screening plant. This machine digs, carries, lifts and dumps in a rapid, continuous movement, controlled by one operator.

SAUERMAN LONG RANGE MACHINES

WHEREVER there is a problem of moving earth, gravel, clay, coal, loose ore, etc., any distance from 100 to 1500 ft., it is likely that the work can be handled at lowest cost with either a Sauerman Slackline or a Sauerman Drag Scraper.

The first cost of a Sauerman machine is less than that of any other equipment of equal range and capacity. Moreover, a Sauerman machine is easy to operate and demands little by way of maintenance. Under favorable conditions, the total operating expense may be as little as 3c per cubic yard handled.

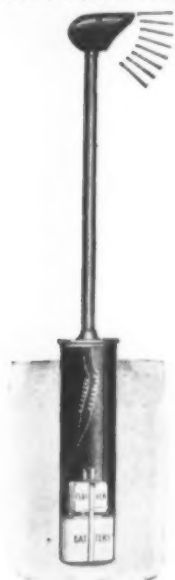
For complete data, write for Catalog 18.

SAUERMAN BROS., 488 S. Clinton Street CHICAGO



Sauerman Drag Scrapers are used to dig and haul materials to a crusher or hopper—to stockpile surplus products—to load materials from a pit, bank or storage pile direct to trucks. A truck-loading setup is shown above.

New Neon Flasher Signal



A new type battery operated neon flashing beacon signal has been brought out by the Lewis Manufacturing Co., Inc., Decatur, Ill. The use of a neon bulb is stated to give a ray which has real penetrating power in fog, mist, rain, snow, or other adverse weather conditions.

This bulb is operated on a nine-volt dry battery, through means of a new type "flasher control." It is claimed that this flasher control is so effective that one battery will operate the neon bulb on a frequency of 80 to 200 times a minute, 24

hours a day, for a period of four to six months.

To protect the battery and "flasher control" from adverse weather conditions, and also from injury, they are placed in a metal well 9 in. in diameter and 3 ft. deep. This well is placed in the ground in the vicinity where flasher signal is desired, and the neon bulb may or may not be connected directly with the metal well; as it can be attached to a post, sign, or other object.

The neon bulb is mounted in a metal shell. Back of the bulb is the reflector which projects the light beams from the bulb through the 5½ in. red diffusing lens in front. A metal visor protects the lens, and also gives greater visibility.

The battery is easily and quickly changed when desired, and the battery cost is practically the only operation cost.

The advantages claimed for this neon flasher are ease of installation, low cost of operation, and greater effectiveness in all kinds of weather and under all traffic conditions.

New Air Line Freeze Preventative

An additional and improved system of air line and air tool freeze preventative known as "Frosto" is being marketed by the Sullivan Machinery Co. to supplement "Tanner Gas" which has proven so successful on construction, industrial and mining operations. Frosto has been developed particularly for industrial applications and wherever electric current is available for its operation. In operation, the Frosto is vaporized in a "vaporizer" and is fed into the compressed air line near the compressor as fast as necessary to prevent freezing of water vapor in the compressed air lines and air tools.

It is stated this system is very effective and economical, current consumption is small and thermostatically controlled and only about a quart of Frosto is required to treat 100,000 cu. ft. of free air under the worst conditions of temperature and humidity.

Bulletins descriptive of Frosto and Tanner Gas freeze preventative systems can be had on application to Sullivan Machinery Co., Michigan City, Ind.

New Pumps

The Sterling Machinery Corp., 411 Southwest Blvd., Kansas City, Mo., has brought out new 2 in. and 3 in. aluminum alloy pumps and a new 3 in. pump made of wear-resisting close-grained nickel semi-steel.



New 2 in. Lightweight Aluminum Alloy Pump

These new self-priming pumps are light weight, compact and portable. Due to Sterling's many years experience in manufacturing self-priming pumps they have been able to incorporate in these new models numerous features they have developed through years of constant improvement in self-priming pump design. The new positive driven shaft seal requiring no attention except lubrication once a season with ordinary engine oil, the larger air handling capacity and faster priming, the higher efficiency, all are incorporated in these new lightweight pumps.

New Type Cotton Tire Cord for High Speed Truck, Bus Operation

A new type of cotton tire cord, designed primarily to reduce heat generated at high speeds in truck and bus tires, has been announced by T. G. Graham, vice president of The B. F. Goodrich Co., Akron, O. The new cord, developed after months of research, is of entirely different construction. The new tire cord is stated to give unusual strength without bulk and materially reduces operating temperatures of tires.

New Electrode for Welding with Small A. C. Transformer Welders

A new mild steel arc welding electrode, designed particularly for use with small alternating current transformer type arc welders which is said to simplify welding with this type of equipment and provide weld metal of high quality, is announced by The Lincoln Electric Co., Cleveland, O.

"Transweld" has a very heavy extruded coating and has a very stable arc, easy

to strike and hold. Because of its stable arc the electrode permits making welds in smooth well-shaped beads. Another advantage is in regard to slag removal. Slag is easily removed from "Transweld" deposits.

Weld metal produced by the electrode possesses high physical properties. Tensile strength is 75,000 to 85,000 lb. per sq. in., yield point 60,000 to 68,000 lb. per sq. in., and ductility 20 to 30 per cent elongation in 2 in.

"Transweld" is suitable for making all types of welds in flat, horizontal, vertical or overhead position. The electrode operates equally well with direct current of either straight or reversed polarity.

"Transweld" is made in three sizes: 3/32, 1/8 and 5/32-in. The smaller size comes in 12-in. lengths, the other two in 14-in.

WITH THE MANUFACTURERS

Elmer J. Scheurman Dies

Elmer J. Scheurman, sales manager of the Jaeger Machine Co., Columbus, O., died Nov. 26. During his 20 years of association with the Jaeger Machine Co. and the Lakewood Engineering Co. he made a host of intimate friends who regret his untimely death.

Electric Hose & Rubber Co. Opens New Eastern Sales Office

The Electric Hose & Rubber Co., has opened a new and larger eastern sales office at Room 919 Nine Rockefeller Plaza, New York City. The new office, occupying more than 600 sq. ft. of floor space, will serve as headquarters for A. B. Dougall, General Sales Manager of the company, and D. C. Smalley, Manager of Metropolitan Sales Division. All sales correspondence, orders and inquiries of Eastern origin should be addressed to this new address. The company's general executive and administrative offices will remain at the factory in Wilmington, Del.

Dimick and Benz Now With Iron & Steel Products, Inc.

Iron & Steel Products, Inc., Chicago (Hegewisch), Ill., have obtained the services of Louis H. Dimick, formerly connected with Clapp, Riley & Hall Equipment Co., in their Chicago and Pittsburgh offices, and well acquainted with leading contractors and operating officials of various railroads and industrial plants, and C. William Benz, C.E., M.E., for eight years with Cudahy Packing Co., and Crlx Lines. Before that he was with Standard Steel Car Co. Both will have their headquarters in the Company's General Offices at Hegewisch. As announced recently this concern acquired a 27-acre freight car shop there a short while ago.

New Director of Sales for Marmon-Herrington

The appointment of C. Alfred Campbell, nationally known automotive sales, advertising, and sales promotion engineer, to the position of general sales director, has been announced by Bert Dingley, vice-president of The Marmon-Herrington Co., Indianapolis, Ind., manufacturer of all-wheel-drive passenger cars, commercial vehicles and trucks. The company also has brought out recently, a track-laying tractor.



C. Alfred Campbell

Mr. Campbell, a resident of Indianapolis for many years, has had an extensive business experience—having been associated with several leading companies in the automotive industry, specializing in commercial and industrial transportation units. His broad knowledge of the problems of dealers, and his wide personal acquaintance in the trade undoubtedly will prove a valuable asset to the company.

In addition to its regular line of heavy duty all-wheel-drive trucks and track-laying tractors, the company converts standard Ford passenger cars, commercial vehicles and trucks into all-wheel-drive units.

Representatives of three leading motion picture news reels recently spent a full day in the Marmon-Herrington plant and proving grounds, taking pictures of the new track-laying tractor in action. These are being released in motion picture houses throughout the country.

The officers of the Marmon-Herrington Co., are Walter C. Marmon, chairman of the board of directors; A. W. Herrington, president; Bert Dingley, vice-president and D. I. Glossbrenner, secretary and treasurer. Mr. Campbell will serve as general director of sales.

Gustafson Appointed Assistant District Engineer for P.C.A.

E. N. Gustafson, a practicing civil engineer in the Texas Gulf Coast section for more than 25 years, has been appointed assistant district engineer of the Portland Cement Association with headquarters in Austin. Mr. Gustafson will be assistant to C. A. Clark, district engineer in the Texas region.

Mr. Gustafson attended Southwestern University and the University of Texas. After a number of years of experience in irrigation, conservation and flood control work he became City Engineer of Bay City and Palacios. He was also chief engineer on the largest privately owned irrigation system in Texas and prepared the survey and report for the Brazos River rice irrigation project now under way.

For two years, Mr. Gustafson was chairman of the Governor's State Engi-

neers' Committee on the Colorado River watershed. He has also been in charge of numerous highway construction projects as resident engineer and division engineer for the State Highway Department. For the past two years he has been on the engineering staff of the Portland Cement Association in Texas.

Wilson Now Manager New York Sales District For American Rolling Mill

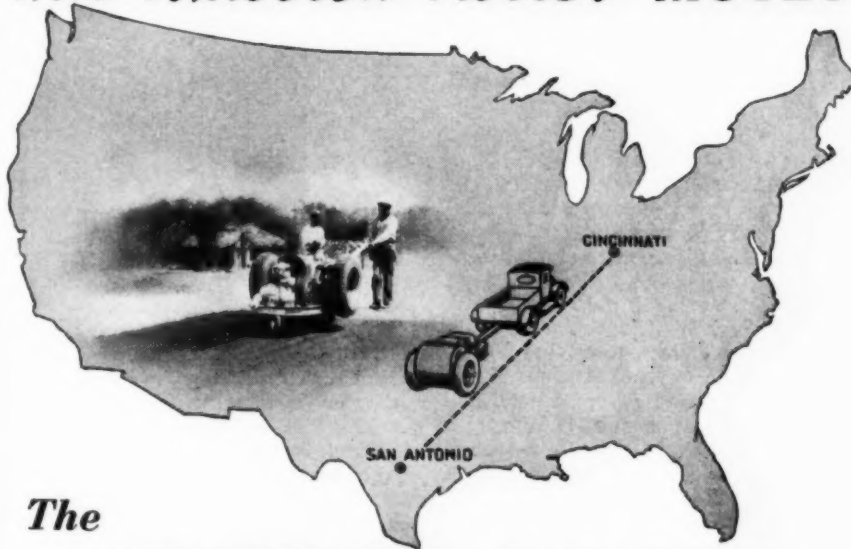
Murray B. Wilson, associated with Armco since 1923, has been named manager of the New York sales district of The American Rolling Mill Company, Middle-

town, O., according to H. M. Richards, manager of the sheet and strip sales division. Following his graduation from Miami University, Oxford, Ohio, Mr. Wilson started as a mill worker at Armco's Middletown plant. He later was assigned to the home office sales division. Since 1927, he has been attached to the Detroit sales district office of the company. He succeeds Cliff Spear, who was forced to curtail his activities because of continued ill health.

Tuthill Announces New Division

The Tuthill Spring Co., 760 Polk St., Chicago, Ill., has announced a new division of the company—The Metallizing

The Wheeled Roller MOVES



The

WHEELED ROLLER

heretofore a product of the Wheeled Roller Corp., San Antonio, Texas, will, beginning January 1, 1938, be manufactured and sold exclusively by

LITTLEFORD BROS.

454 E. Pearl St.

CINCINNATI, OHIO

Universal approval and ever increasing demand for Wheeled Rollers requires—

1. A central point of manufacture. For better deliveries and lower shipping costs.
2. The use of standard parts in their construction. For adequate service on new and operating rollers.
3. A nation wide sales and service arrangement. To properly sell and service Wheeled Rollers, everywhere.

Wheeled Rollers fit in perfectly with the Littleford line—the most complete line of Road Maintenance Equipment on the market today.

Look for the Littleford Motorized Wheeled Roller at the Road Show, Cleveland, Jan. 17-21.

Division. Metallizing is the process of spraying molten metal onto any solid object. It is done by feeding a wire of any desired material (steel, copper, lead, zinc, aluminum, etc.) through a "gun" in the body of which is an oxy-acetylene flame. This melts the wire and blows the stream of molten metal onto the object to be metallized. The purposes of the process are in three fields: (1) To build up worn parts such as shafts, cylinders, rolls, bearing journals, patterns, castings, etc. (2) To prevent corrosion—any object from bolts to bridges may be metallized: Steel sign frames, tanks, laundry equipment, burner frames, boiler grates, etc., are metallized with zinc, aluminum, cadmium, stainless steel, or other corrosion-proof metals. (3) For decorative purposes: Plaster statues, light fixtures, ornamental parts of wood, stone, leather, steel or other materials, can be metallized to preserve and to ornament.

W. E. Wechter to Head Worthington Oil and Gas Atlantic Division

The appointment of W. E. Wechter as Manager of Oil and Gas Engine Sales, Atlantic Division, is announced by Worthington Pump and Machinery Corporation. Mr. Wechter succeeds R. L. Howes, recently resigned. In his new duties, Mr. Wechter will supervise oil and gas engine sales in the Atlantic seaboard territory, in which are the Worthington offices at Boston, New York, Philadelphia, Washington and Atlanta. Since his graduation from Purdue University in 1923, Mr. Wechter has been connected with the Worthington organization, having held successively the positions of salesman in Atlanta territory, Atlanta District Sales Manager, Detroit District Sales Manager, and Assistant Manager of the Oil and Gas Engine Division at Harrison, New Jersey. He will now make his headquarters at the Worthington office, 2 Park Ave., New York City.

Jahn Co. Moves to Larger Quarters

The C. R. Jahn Co., manufacturers of heavy duty and single purpose trailers, announces removal to new and larger plant quarters at 1351 W. 37th Place, Chicago. Facilities provide for complete control of assembly and shipment with inside rail loading. General sales offices are still located at 228 N. La Salle St., Chicago.

Morgan Appointed Assistant to President of Reo

Don E. Bates, president and general manager of the Reo Motor Car Co., announces the appointment of Frank N. Morgan to the newly created position of Assistant to the President. Mr. Morgan has been with the Reo sales organization for the past eight years as special Speed Wagon representative, zone and regional manager, and more recently as manager of Reo's Los Angeles branch. He was formerly connected with the Cleveland Tractor Co., for seven years.

Widely known among the Reo distributor and dealer organization, Mr. Morgan

brings to his new post an intimate knowledge of merchandising and transportation problems. His wide experience will be helpful in developing still further co-ordination of sales, manufacturing and engineering activities.

Mr. Morgan is succeeded as manager of the Los Angeles branch by Mr. Ray Lawrence, who has been his assistant there.

Link-Belt Personnel Changes

Announcement is made by Link-Belt Co., Chicago, Ill., of the following changes in the personnel of its management and sales organization:

Harold L. Hoefman has been appointed manager of the Link-Belt plant, warehouse and sales office at Atlanta, Ga., to succeed I. H. Barbee, who died on Nov. 4. Mr. Hoefman brings a wide experi-



H. L. Hoefman

ence to his new position, having started with the company 17 years ago as a draftsman in the Pershing Road Chicago plant engineering department. After working in several divisions of this department, he was transferred to the sales department, serving first as sales engineer at the Chicago office, then at Kansas City, Dallas, and Indianapolis. Since 1935 he has been manager of the Link-Belt warehouse and sales office in Detroit.

George A. Paige has been appointed manager of the Link-Belt warehouse and sales office in Detroit. Mr. Paige also started his Link-Belt career in the Chicago plant engineering department 17



G. A. Paige

years ago. Three years later he was transferred to the sales department, serving first at the Chicago office. In 1926 he was given the position of sales engineer in Detroit territory. Since last year he has been district sales manager at Pittsburgh.

Laurance O. Millard has been appointed district sales manager at Pittsburgh. Mr. Millard joined the Chicago plant engineering department in 1913, and was transferred to the Cleveland office as sales engineer in 1923. In 1929 he returned to



L. O. Millard

the Chicago plant as a specialist in power plant coal and ashes handling machinery sales. Since 1933 he has been district sales manager at Cleveland.

Paul V. Wheeler has been appointed district sales manager at Cleveland. He started his Link-Belt career at the company's Pittsburgh office in 1907, first handling general merchandise sales, and



P. V. Wheeler

then specializing on positive drive applications. Mr. Wheeler became associated with the Cleveland office in 1921, when the office was first opened, and has been an important factor in its conduct ever since.

Meldrum and Fewsmith Inc. Purchase Sun Advertising Co.

Meldrum and Fewsmith, Inc., of Cleveland, O., have recently announced the purchase of the Sun Advertising Co., of Toledo, O. Effective immediately, the Sun Advertising Co., will be known as Meldrum and Fewsmith, Inc., Toledo, O., and will operate as a branch of Meldrum and Fewsmith, Inc., Cleveland. For the present, at least, the personnel of the Toledo branch will remain as it is, and all contacts with reference to any business originating from there should be taken up with Toledo. Orders for business from the Toledo branch will originate in Toledo and billing should be sent to Toledo. Payments on Toledo business will likewise be made from the Toledo Office. Business originating from the Cleveland Office will continue to be handled as heretofore.

Bauman Now Highway Material Engineer for Toncan

The Toncan Culvert Manufacturers' Association, Republic Building, Cleveland, O., announce the addition of Mr. E. W. Bauman, who has joined them in the capacity of highway materials engineer. Mr. Bauman recently resigned as engineer of materials and tests of the Tennessee State Highway Department. He is a member of the American Society of Civil Engineers, American Society of

Do You Know That—



AS IT MAY SEEM, THE FAMED UNICOY ROAD, LONG A LINK IN THE HIGHWAY SYSTEM OF THE SOUTH, WAS ORIGINALLY OWNED IN PART BY THE CHEROKEE NATION, AN INDEPENDENT INDIAN COMMUNITY, WEDGED TWIXT GEORGIA AND TENNESSEE, WHICH HAD ITS OWN GOVERNMENT, FRAMED ITS OWN LAWS, AND DEVELOPED A HIGH CULTURE. UNDER A SPECIAL AGREEMENT, THIS COMMUNITY WAS PAID TO PERMIT U.S. CITIZENS TO TRAVEL THE ROAD THROUGH CHEROKEE TERRITORY. HAD NOT CONDITIONS DEVELOPED WHICH OBLIGED THIS PEOPLE LATER TO MIGRATE FURTHER WEST, THE CHEROKEE, UNDER TERMS OF THE AGREEMENT, WOULD EVENTUALLY HAVE OWNED ENTIRELY THIS TURNPIKE, BUILT AFTER 1813.

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CANTON, OHIO.....BELDEN	OWENSBORO, KENTUCKY.....OWENSBORO	WACO, TEXAS.....RALEIGH
ST. LOUIS, MO.....MARK TWAIN	WACO, TEXAS.....RALEIGH	

PICK, as proof, holds alone

Testing Materials, serving on Committees C-1, C-9, A-5 and D-4. In addition to these activities, Mr. Bauman was also on the Materials Committee of the American Association of State Highway Officials and he was in charge of state contact for the Highway Research Board. Mr. Bauman's experience and broad knowledge of the highway drainage field equips him well for his new duties with the Toncan Culvert Manufacturers' Association.

Organization Changes Caterpillar Tractor Co.

Five important changes in the organization of Caterpillar Tractor Co., were recently announced by President B. C. Heacock. C. Parker Holt turns over the



A. T. Brown

office of executive vice-president to A. T. Brown, formerly vice-president generally administering the accounting, treasury, traffic and parts departments. Mr. Holt returns to the San Leandro, Calif., office



A. T. Neumiller

of the company where, as vice-president, he will direct all "Caterpillar" activities there and coordinate the work of the several departments with the headquarters of those departments in the Peoria offices.



D. G. Sherwin

Two new vice-presidents have been elected. L. B. Neumiller, formerly director of industrial relations, is now vice-president generally administering the parts, service and traffic departments as well as continuing active management of industrial relations. D. G. Sherwin has been advanced from treasurer to vice-president generally administering the advertising, sales and treasury departments.

D. A. Robinson, formerly assistant



D. A. Robinson

treasurer, has been elected treasurer of the company to fill the vacancy created by the promotion of Mr. Sherwin. The newly elected officers assumed their respective duties early in November.

Littleford Takes Over Wheeled Roller

The Wheeled Roller will be manufactured and sold exclusively by Littleford Bros., 454 E. Pearl St., Cincinnati, Ohio, beginning Jan. 1, 1938.

Originated and developed by the Wheeled Roller Corp., of San Antonio, Texas, the easy portability and many practical uses for this roller have won for it wide acceptance among street and highway officials and contractors everywhere. Since the introduction of the motorized wheeled roller, this demand has grown until there is a definite need for a geographically central point of manufacture to facilitate deliveries. The incorporation of nationally distributed standard parts in its manufacture is another necessity. A nation wide sales and service arrangement has become imperative to the proper handling of the business. All these requisites are obtained in the Littleford set-up. The addition of this maintenance roller unit augments the Littleford line of road maintenance equipment nicely.

The unit will continue to be known as the Wheeled Roller. Important improvements in the mechanical design are being engineered by Littleford Bros., and will be brought out in their new models to be placed on the market Jan. 1, 1938. Full details may be had by writing Littleford Bros., 454 E. Pearl St., Cincinnati, Ohio.

Schaefer Joins Federal Truck

Appointment of K. M. Schaefer as Assistant to the General Manager, assigned to sales, has been announced by R. W. Ruddon, Vice-President and General Manager of Federal Motor Truck Company. Schaefer, now collaborating with Mr. Ruddon in planning a sales program for the Detroit company, was recently Vice-President and General Sales Manager of Silver Dome, Inc. His experience in the automotive field dates back from 1922 when he joined Paige Motor Car Co. More recently, he was with the Pontiac Division of General Motors Corporation in service, sales promotion and field capacities, and previous to that was general sales manager of the Norge Corporation, Detroit.

Division Advertising Managers Appointed at Westinghouse

H. S. Schuler has been appointed division manager of industry advertising of the Westinghouse Electric & Manufacturing Company it is announced by J. M. McKibbin, sales promotion and apparatus advertising manager. Mr. Schuler came to Westinghouse from the advertising agency of Ketchum, McLeod & Grove, Inc., where he was an account executive. Other division advertising managers appointed by Mr. McKibbin are T. H. Cable and J. H. Thompson.

International Harvester Building Large Addition to Its Tractor Works

Construction is now underway and the work will be completed by next May 1 on a large addition to the International Harvester Co.'s tractor works at 2600 W. 31st Boulevard Chicago, Ill. The new addition, with buildings and equipment, will cost in excess of \$1,000,000.

The new addition will be devoted entirely to the production of International Harvester's line of crawler-type tractors as distinguished from wheel-type tractors. This line of tractors, known as TracTracTors, is used in both agriculture and industry. Five different-size models will be produced in the enlarged plant, including two models powered by Diesel motors. The Diesel engines will continue to be made in the company's manufacturing works at Milwaukee.

A one-story building of saw-tooth design, with brick and steel walls and gypsum roof, the new structure will add 240,000 sq. ft. (6½ acres) of floor space, bringing the total floor space of the plant to approximately 1,400,000 sq. ft.

TracTracTor machining and assembling operations will be conducted in the new space, with the assembly line lengthened to 500 ft. and its present output of 40 crawler tractors per day increased to 75.

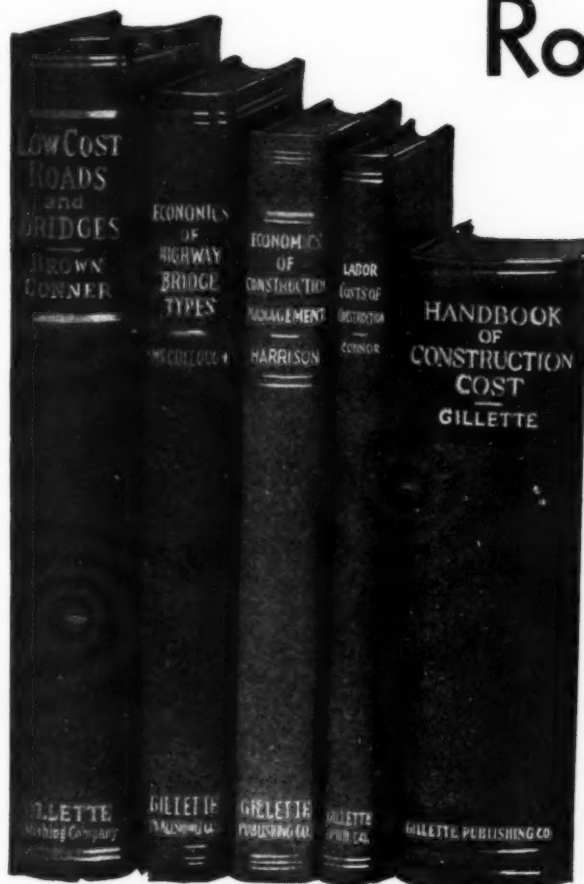
An endless chain conveyor, representing the most modern type of progressive assembly of crawler tractors, will be installed, while the machine shops are to be specially equipped for the milling and drilling of such heavy parts as main frames, crankcases, and crankshafts.

The equipment will include an unusual machine known as a vertical broacher which, by means of hydraulic pressure, planes the top and bottom edges of the links of the crawler track chains to within an inspection tolerance of thirty-two one-thousandths of an inch.

Max H. Schachner Made Assistant Sales Manager of Winton Engine Corp.

Appointment of Mr. Max H. Schachner as Assistant Sales Manager of the Winton Engine Corporation, subsidiary of General Motors, is announced by Mr. William J. Davidson, General Sales Manager of Winton. His principal responsibility will be direction of the sale of the new Winton two-cycle diesel engine to manufacturers and distributors.

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The Road Builders' Library has been planned to give in a clear, concise form, the most up-to-date data available. In its six volumes you will find summarized the experience and practical knowledge of some of the most successful highway engineers. It is invaluable as a reference source for your NEW jobs. It tells how similar work was effectively and profitably handled elsewhere—pointing out what the limitations are and how results may best be obtained. It gives you useful calculations already worked out, tables, charts, and other useful data that provides a short-cut to *Profit-Making*.

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NEW LITERATURE

Snow Plows—A comprehensive catalog on its Champion snow plows has been issued by the Good Roads Machinery Co., Kennett Square, Pa. The catalog contains 72 pages and in it are illustrated and described 8 types and over 30 models of plows. Included also are descriptions and illustrations of plow attachments, sand and cinder spreaders, as well as interesting data on snow removal and ice treatment.

Hoists and Dump Bodies—The hoist and body division of Gar Wood Industries, Inc., has recently released two, profusely illustrated, 6-page bulletins. Bulletin No. 2 describes and illustrates Gar Wood heavy-duty, cam and roller hoists. Bulletin No. 3 deals with Gar Wood heavy-duty, dump bodies. This new Gar Wood literature is printed in two, attractive colors. The folded size of each is 8½ by 11 in. for convenient inspection and filing. Copies of these new bulletins may be obtained by writing to the hoist and body division of Gar Wood Industries, Inc., Detroit, Mich.

Excavating Equipment—An attractive new catalog dealing with its excavating machinery has been released by the Koehring Co., for general distribution to the contracting and industrial markets. It represents a complete presentation of Koehring excavators. It contains 32 pages of illustrations depicting the excavators on the job and dissembled for detail construction views. Copies may be had by addressing the company at 3026 West Concordia Ave., Milwaukee, Wis., giving business or position with company.

Corrugated Metal Drainage Pipe—A new pamphlet issued by the Armco Culvert Mfrs. Association, Middletown, O., traces the history of corrugated metal drainage pipe from the time it was invented in 1896 to the present day. A copy of the folder "Your Guide to Better Drainage" may be obtained by writing to the Association or any of its member companies. Tables show that when the first corrugated culverts were installed, total motor vehicle registration was 16, compared to 26,221,052 for the present day. Photos in the booklet show the durability of Armco ingot iron and the results of field investigations during the last quarter century. It also discusses the development of Armco paved invert pipe in 1925, concluding with a description of the company's most recent achievement—asbestos bonded Armco pipe. A chart reveals the chronology of major improvements in corrugated metal drainage pipe, pioneered and perfected by Armco engineers.

Roadbed Stabilization by Drainage—H. E. Cotton, drainage engineer of Armco Culvert Manufacturers Association, has written a lengthy treatise on "Roadbed Stabilization by Drainage," presented originally before the convention of the American Road Builders' Association in New Orleans and later published in *The Highway Magazine*. Reprints may be obtained by writing to the Association's

offices at Middletown, O. The article is prefaced by a discussion on "Subgrades vs. Pavement Failures," by H. H. Houk, chief engineer of the Alabama State Highway Department. Mr. Cotton discusses in detail highway subdrains, the use of the soil auger, the location and depth of subdrains, cut slopes, the installation of pipe, and presents tables showing the depth of flow and discharges required to move various solids.

Non-Skid Floor Plates—A 20-page catalog has been issued by the Central Iron & Steel Co., Harrisburg, Pa., illustrating and describing its rolled steel floor plates. Complete specifications and "extras" for the plates are included.

Floods on Illinois Streams—Bulletin No. 296, "Magnitude and Frequency of Floods on Illinois Streams," by G. W. Pickels, which has just been issued by the Engineering Experiment Station of the University of Illinois, contains a presentation and an analysis of flood-flow data on 24 Illinois streams, taken from the records of the United States Geological Survey. The purpose of the bulletin is to provide as much information as possible as to the frequency with which flood flows of certain magnitudes may be expected. For watersheds in Illinois over 200 square miles in area, it is believed that the forecasts of flood magnitudes for frequencies of from once in five years to once in one hundred years are as reliable as can be obtained from the available flow data. It must be borne in mind, however, that the data used in this study are based on comparatively short records, and that the assumption has been made that the periods of record are representative ones; time may possibly show that these periods were not truly representative ones. To cover uncertainties of this nature the author recommends the use of safety factors, of varying amount according to the particular circumstances of the case in question, in applying the data presented in this bulletin to design problems. Until May 1, 1938, or until the supply available for free distribution is exhausted, copies of Bulletin No. 296 may be obtained without charge upon application to Engineering Experiment Station, Urbana, Ill.

Snow Removal Equipment—Four circulars on snow removal have been issued by The Cleveland Tractor Co., Cleveland, O. One deals with the removal of snow from sidewalks. Another illustrates and describes the Clectrac and its operation in snow removal. The third is a pictorial presentation of the tractor on snow removal work in many parts of the country. The other booklet is devoted to the Sargent-Clectrac conversion group, which includes a power unit, a bulldozer and a snow plow. In this group the bulldozer and snow plow are interchangeable with each other. The power unit, including the hook-up, is common to both.

Sand Distributor—The Auburn Metal Products Co., Auburn, Ind., has issued a circular illustrating and describing its

Butler sand distributor, which distributes sand and aggregates from trucks at any speed. Specifications of Models P and H are given.

Concrete Buckets—A 16-page, completely illustrated descriptive booklet on roller gate concrete buckets, has been issued by the Blaw-Knox Co., Pittsburgh, Penn. Known as Catalog 1586, the 8½ in. x 11 in. pamphlet contains details and illustrations of the various kinds of roller gate buckets including cableway operating types, underwater types, and special designs for unusual requirements. A complete list of specifications and sizes is included. A copy will be sent upon request of interested parties.

Parking Meter—A circular describing its Red Ball parking meter has been issued by The Martin Timing Devices Co., 21 Besse Place, Springfield, Mass. This meter is very flexible as any time or price arrangement can be set up. It has a further advantage that the red ball as an indicator of expired time can be seen from any direction a block away. In addition the chiseler and cheater cannot take advantage of the other man's unexpired time as there is nothing to indicate just when the red ball will come up.

Concrete Pavement Joint—Three circulars dealing with its flexible joint have been issued by the Parabond Corp. of America, 333 Washington St., Boston, Mass. This joint is a flexible rubber compound which is placed in one operation and forms its own bond.

Crushers—The Universal Crusher Co., Cedar Rapids, Ia., has just issued Bulletin No. 100 covering their line of Bronze Bearing Jaw Crushers; Bulletin No. 200 covering their line of Roller Bearing Jaw Crushers; Bulletin No. 300 covering Universal Roll Crushers; and Folder No. 19 covering Universal 30-Q Portable Plants. Each Bulletin gives complete construction details, dimensions, specifications and other data. Copies of any one or all of these bulletins may be obtained by addressing the Universal Crusher Co., 625 C Avenue, N. W., Cedar Rapids, Ia.

Winter Heating Equipment—Of timely interest is the new bulletin of Littleford Bros., 454 East Pearl St., Cincinnati, O., covering its line of winter heating equipment. Illustrations, descriptions and specifications are given on concrete heaters, salamanders, heating torches, etc. Ask for Bulletin M-11.

Snow Removal Equipment—"Low Cost Snow Removal" is the title of a 24-page booklet issued by the Barber-Greene Co., Aurora, Ill. It contains much interesting information on snow removal, including a table showing the seasonal snow fall for the last 25 years in large cities. The booklet illustrates and describes the standard Barber-Greene Model 38-D snow loader, and also the new Barber-Greene Junior snow loader—Model 558.

TRAILERS

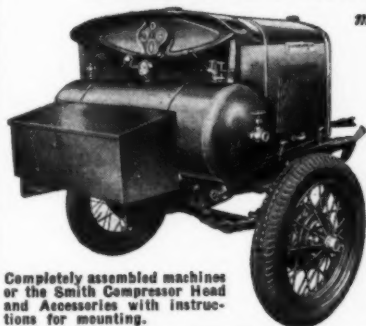
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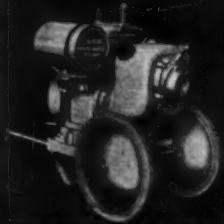
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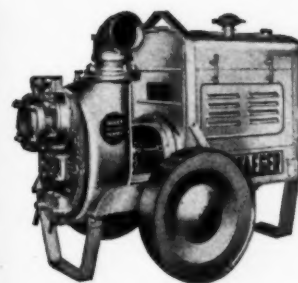
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Rock, Gravel and Sand Equipment—The first two of a series of descriptive bulletins on their rock, gravel and sand equipment has just been issued by the Diamond Iron Works, Inc., Minneapolis, Minn. Bulletin D-37-A illustrates and describes the company's portable quarry plants. Bulletin D-37-B covers the Diamond roller-bearing vibrator screens.

Paved Invert Pipe Sewers—Beautifully illustrated with large photos of actual installations, a new 48-page 8½ x 11 handbook titled "Armco Paved Invert Pipe Sewers" has been published by the Armco Culvert Mfrs. Association, Middletown, O. Consulting engineers, city engineers, municipal officials and others directly interested in sewer construction will be given a copy upon request. The forepart of the book describes how Armco Sewer Pipe distributes the load uniformly around its circumference, and how the long sections are tightly banded together to produce a continuous conduit. Photos show sewer pipe, made of Armco ingot iron, that has been in service for more than 25 years and still is in good condition. Pipe installed early in the century was protected only by a galvanized coating. Progressive improvements since that time make Armco sewer pipe even more durable, the book states. In 1925, a special bituminous material was employed for both the inside and

outside of the pipe, and especially to fill corrugations in the bottom. It was called Armco paved invert pipe. In 1937, Armco perfected a new bonding process, whereby a layer of asbestos felt is pressed into the molten zinc coating—before the bituminous material is applied. The combination provides three-way protection from wear and corrosion. Tables indicate the recommended joints, and standard and special fittings for Armco sewers. Costs of pipe sewers, loading and hauling, excavating, laying, lining and joining are discussed in detail. Seventeen pages in the book are devoted to general data for all types of installations, and to specifications for asbestos bonded Armco sewer pipe.

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